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STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION

DIVISION OF THE
STATE GEOLOGICAL SURVEY
M. M. LEIGHTON, *Chief*

BULLETIN NO. 46

LIMESTONE RESOURCES OF ILLINOIS

BY

FRANK KREY and J. E. LAMAR

IN COOPERATION WITH DIVISION OF HIGHWAYS, DEPARTMENT OF PUBLIC WORKS AND BUILDINGS

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PREFACE

The initiation of the program for concrete roads in Illinois a few years ago brought to the fore the question of the quality and supply of limestone which might be available for concrete aggregate. A study of the limestones of the State which might furnish a source of aggregate was therefore undertaken by the Illinois Geological Survey in cooperation with the State Highway Division. The investigation included an examination of all the shipping quarries in operation, and a field study of favorable sites for future shipping quarries, together with a search for deposits primarily of local importance. This bulletin represents mainly the results of this investigation.

Inasmuch as the limestone resources of the State are now being utilized for a great variety of purposes other than for aggregate and road material, the scope of the bulletin has been made to include descriptions of the other more important uses to which limestone is put.

The field work was done by two members of the State Geological Survey's staff, Messrs. Frank Krey and J. E. Lamar; a large number of physical and chemical tests was made by the Testing Laboratory of the State Highway Division on carefully selected samples; and the data were assembled and the report prepared primarily through the efforts of Mr. Lamar and Mr. Krey.

M. M. Leighton, *Chief,*
State Geological Survey Division

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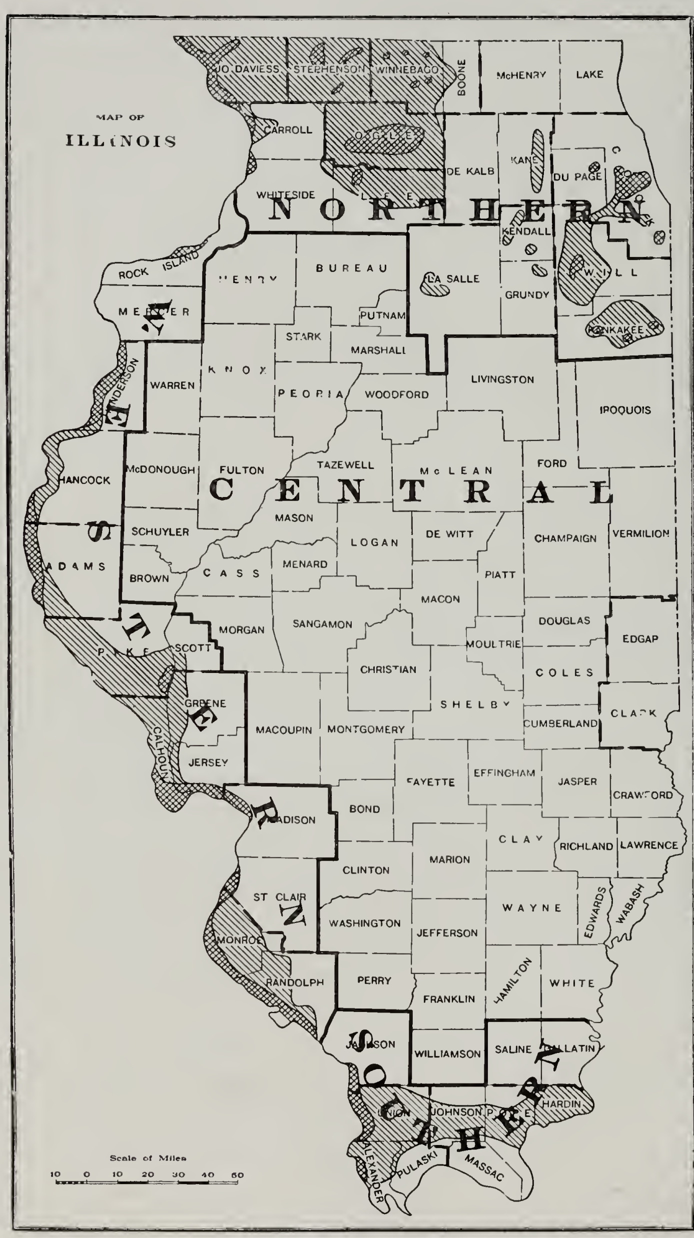


LEGEND

Boundary of general subdivisions of the State used in the report.

Boundaries of unit areas for which separate maps are included.

Areas with a supply of local road material exclusive of that of Pennsylvanian age.

Shipping quarries or sites suitable for shipping quarries.

FIG. 1. Index map of Illinois showing subdivisions used in the report.

LIMESTONE RESOURCES OF ILLINOIS

By Frank Krey and J. E. Lamar

CHAPTER I.—INTRODUCTION

By Frank Krey

General Statement

The present day movement for hard roads has brought to the foreground the question of suitable materials from which to build roads. Each state has turned to its local deposits as a source of supply and as a result, at the present time, certain states favor limestone, some favor gravel and others granite, basalt or related trap rocks for the construction of their hard roads. Illinois contains no exploitable outcrops of igneous rocks and is therefore compelled to rely on deposits of limestone and gravel for its supply of road material (fig. 1). During 1923 Illinois produced 9,020,880 tons of limestone, exclusive of that for cement and lime. Of this amount 5,704,900 tons were sold as road material and concrete aggregate, representing 63 per cent of the total quantity and 65 per cent of the total value of the stone quarried in the State (fig. 2).

The relative quantities and values of the various road metals produced in the United States in 1923[1] are given in Table 1.

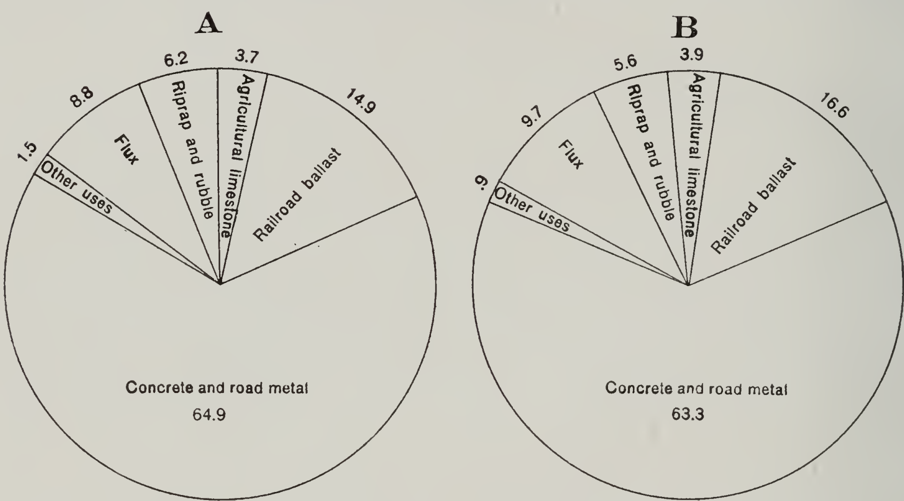
Table 1.—*Quantity and value of road metal produced in United States in 1923*

Kind of material	Use	Value	Quantity
Granite	Paving blocks	$ 3,578,182	41,016,640 blocks
	Road metal and concrete	5,690,464	4,400,410 short tons
Basalt and related trap rocks	Paving blocks	8,342	241,120 blocks
	Road metal and concrete	10,793,201	8,550,600 short tons
Gravel	Building gravel	18,367,713	24,145,463 short tons
	Paving gravel	17,716,779	26,174,112 short tons
Limestone	Paving and curbing	46,830	75,070 cubic feet
	Road metal and concrete	35,925,709	33,382,210 short tons

[1]Loughlin, G. F. and Coons, A. T., Stone: Mineral Resources of the United States in 1923, 1924.

Although the Survey has published reports on the limestone resources in special areas from time to time, no comprehensive and detailed report on the resource for the entire State dealing especially with the availability and adaptability of Illinois limestone for road building has heretofore been attempted. It was with this purpose in view therefore that the special study of the limestone road material resources in Illinois was undertaken.

The distribution of the limestones in Illinois is such that most of the interior portion, comprising about two-thirds of the area of the State, is practically devoid of commercially workable deposits of limestone, while



Total value, $8,309,383 Total production, 9,020,880 short tons

Fig. 2. Relative amounts and value of limestone produced in Illinois during 1923 for uses exclusive of that for cement and lime manufacture.

the remaining third of the State, which includes the northern end and a rather narrow belt along the western and southern portions, contains an abundance of workable limestone outcrops (fig. 1). As a result, limestone road materials used in the central portion of the State must be shipped in from the northern, western, or southern borders. Therefore, special emphasis is laid on shipping quarries and possible additional sites for shipping quarries while outcrops of local importance are treated only in a general way.

Methods Employed

All shipping quarries were visited and data collected regarding location, character of the rock, quarry practice, equipment, capacity of the plant, transportation facilities, and miscellaneous details. Although the field work was carried on during the summers of 1919 and 1920, revised data have been incorporated for all shipping quarries whose management have responded to the Survey's inquiries.

Outcrops easily accessible to railroads were examined and notes taken on location, kind and thickness of rock, quantity available, amount of overburden, transportation factors and other related matters. Limestone exposures of limited extent or located considerable distance from a railroad were not described in great detail, but in every case a careful examination was made of the bedding, thickness of beds, composition, texture, hardness, toughness, color, jointing, cleavage, presence of fossils and variations in weathering.

Samples were obtained where possible, unless the rocks were badly weathered or had previously been sampled. An effort was made to take only representative samples. In bluff areas where the rock face was exceedingly steep, samples were obtained from the nearest ravine where the same section of rock was exposed. The general gross uniformity of the different limestones over limited areas made this method more satisfactory than attempting to obtain samples from localities where conditions were unfavorable.

Scope of the Report

This report deals with the distribution and general properties of limestone road materials and the kinds of tests made to determine the suitability of a rock for road material. Table 5 is presented giving the results of all physical tests previously published by the United States Geological Survey and the Illinois State Geological Survey, together with those made by the Highway Department during this investigation. Attention is called to the value of the tests made, to a description of the methods of sampling, and to the mode of occurrence and distribution of limestone in the State. For the benefit of persons unfamiliar with the quarrying industry a chapter is also included which deals with current quarry practice and with the factors to be considered in selecting a quarry site.

As limestone has many uses in addition to that of road material, quarries opened primarily for the production of road material may increase their output by supplying rock for other purposes. In order to furnish information regarding other uses of limestone, a chapter has been compiled discussing briefly the various uses thereof, and the quantity and quality of rock used for such purposes. Table 17 gives all chemical analyses of Illinois rocks published by the United States Geological Survey or Illinois State Geological Survey and also those obtained from the Highway Department and elsewhere during this investigation.

Acknowledgments

The writers wish to acknowledge their indebtedness to the quarry owners and operators for their courtesy and kindness in giving information regarding their plants; also to the State Highway Division for their cooperation in making the tests of the samples. Acknowledgment is due Mr. F. W DeWolf, former chief of the Survey under whose direction the field work of this investigation was carried on, for his kindly assistance and guidance; to Dr. M. M. Leighton, present chief of the Survey for his valuable criticism of the manuscript and to Mr. C. R. Schroyer who helped devise the schedule which was used in the examination of quarries and outcrops and who assisted in the beginning of this investigation. The valuable aid of the field assistants, Mr. Perle Keller and Mr. Robert Miessler is also here gratefully acknowledged. Many of the illustrations were secured from the Rock Products and Cement, Mill and Quarry magazines through the courtesy of the Tradepress Publishing Corporation and the International Trade Press, Inc., whose cooperation is greatly appreciated.

CHAPTER II.—ORIGIN AND DISTRIBUTION OF LIMESTONE AND DOLOMITE IN ILLINOIS

By Frank Krey and J. E. Lamar

General Statement

Most limestones have been formed in two different ways—by organic and by chemical agencies and processes. The first mode of origin probably is responsible for the formation of most Illinois limestones. It involves the extraction of the calcium carbonate from sea water by animals such as corals, crinoids, mollusks and foraminifera which secrete shells or have calcareous skeletons. When these animals die their shells and tests accumulate at the bottom of the ocean. Many of the shells and tests are washed about and broken up so as to be no longer recognizable but some are preserved and constitute the fossils found in the present rocks. In the course of a very long time great thicknesses of these shell fragments and muds derived from them accumulated and contemporaneously, compacting, cementation, recrystallization with accompanying chemical changes effected consolidation of these shell particles into limestone. Subsequently the limestone beds were elevated above the level of the ocean and converted into land areas.

Among the agencies which produce limestone by precipitation from sea water, several types of algae are of great importance. These small plants have probably produced not only considerable beds of limestone relatively free from skeletal and shell debris, but may also have contributed to the formation of the fine-grained material commonly filling the interstices between the shell and skeletal fragments of granular limestones. In places where evaporation of water containing calcium carbonate in solution, or where the escape of carbon dioxide from water charged with it are favored, chemical precipitates are commonly formed which include tufa, travertine, calcareous sinter, or stalactitic growths.

Limestone is composed dominantly of calcium carbonate. Dolomite, on the other hand, is composed not only of calcium carbonate but also of magnesium carbonate which may comprise as much as 45 per cent of the rock.

It is commonly accepted that most dolomites have been formed by the introduction of magnesium carbonate into limestones by ground water after their formation either while they are still beneath the ocean or after they are above the sea. Such dolomites may therefore be considered altered limestones.

All of the important limestone formations of Illinois were deposited during the older geologic periods (Table 2). Epochs of limestone deposition alternated with epochs of either shale or sandstone deposition or both, so that various and distinct limestone formations deposited at different times and under different conditions have as a result different physical and chemical characteristics. The oldest limestone formations of Illinois are Ordovician in age, and the others successively belong to the Silurian, Devonian, Mississippian and Pennsylvanian periods. The Pennsylvanian strata consisting dominantly of shales and sandstones with minor amounts of limestones, originally buried most of the older formations, but subsequent warping and erosion have exposed the latter along the belts and in the areas shown in figure 1. The warping produced a broad spoon-shaped basin whose axis trends in a north-south direction through the central part of the State as far north as the upper Illinois River. The upwarp was great enough along the western and southern borders of the State to permit erosion to remove the Pennsylvanian beds and to expose the underlying Mississippian and older strata. The abundance of limestone in these older strata insures a supply of this material along the western and southern borders of the State, whereas in the interior of the State such limestones are buried by the thick shales and sandstones of the Pennsylvanian system and by glacial deposits.

Whatever Pennsylvanian sediments were once present in the northern part of the State have been almost entirely removed by erosion, but the glacial drift is so thick in the northeastern part and locally elsewhere that older rock outcrops are for the most part localized.

Table 2 gives the geologic column for the State and describes briefly the character, thickness, distribution and suitability of the rock for use as road material.

TABLE 2.—*Generalized geologic column and description of formations in Illinois*

System	Formation	Character	Thickness	Distribution
			Feet	
Pleistocene		Glacial till, sand, gravel, loess and alluvium	0-225	Comprises mantle rock over whole State as far south as Carbondale, except for small area in the northwest corner of State and in Calhoun County
Pliocene and Eocene		Unconsolidated clay, sand, gravel, and lignitic material	150+	Found only in extreme southern part of State
Cretaceous	Ripley	Unconsolidated sands and clays	40+	Found chiefly south of Cache River in southern end of State
Pennsylvanian	McLeansboro	Shales, sandstones thin limestones, and some coal	0-1000	Covers State except northern end and a narrow belt along the west and south margins of State
	Carbondale	Shales, sandstones thin limestones, and coals	0-320	Forms narrow belt about edge of McLeansboro
	Pottsville	Sandstones, shales and thin coals	Thin in north but reaches thickness of 750 in south	Prominent bluff-forming rock in southern Illinois. Outcrop corresponds closely to Carbondale
Mississippian	Chester group	Alternating series of sandstones, limestones, and shales. Limestones generally contain interbedded shale	0-1000	Found only in southern Illinois where it outcrops below the Pennsylvanian close to borders of the State
	Ste. Genevieve	Mainly massive limestone, but may contain thin sandstone and shale beds in upper portion. Compact limestone of high purity. Oolitic beds prominent in upper portion	250	Outcrops in Hardin, Johnson, Union, Massac, and Monroe counties

TABLE 2.—*Generalized geologic column and description of formations in Illinois*—Continued

System	Formation	Character	Thickness	Distribution
			Feet	
Mississippian (continued)	St. Louis	In southern part of State massive limestone, compact, fine grained, many beds pure limestone but may locally be very cherty. In western portion of State formation is thin and contains interbedded shale	0-250	Outcrops in Mississippi River bluff at south end of Calhoun County, near Alton, East St. Louis and in Monroe County. Makes up much of bed rock of Hardin and Union counties. Also outcrops in Walkers Hill near Grand Tower in Jackson County. Scattered outcrops also occur in western part of the State
	Spergen (Salem)	In western portion of State the limestone is thin, often sandy and contains shaly layers. In southern Illinois it is a massive, pure limestone often partly granular and locally contains oolitic beds. In Union County it is a massive, coarsely granular limestone	10-250	Found below the St. Louis in western Illinois, but its outcrops are most prominent in Monroe and Union counties
	Warsaw	Consists of interbedded shales and limestones. Many shales contain large geodes and are magnesian. In Hardin County the Warsaw consists of massive limestone, compact to granular, not distinguished from Spergen in Union County	40-250	Shaly phase outcrops in western part of State, north of Alton, and in Monroe County. Limestone phase outcrops in Union and Hardin counties

TABLE 2.—*Generalized geologic column and description of formations in Illinois*—Continued

System	Formation	Character	Thickness	Distribution
			Feet	
Mississippian (continued)	Keokuk	Recognized only in western part of State where it consists of shale and interbedded limestone in upper portion and of crinoidal limestone containing abundant chert in lower portion	0-125	Outcrops in western Illinois in vicinity of Mississippi and Illinois river bluffs
	Burlington	Massive, light gray, coarsely granular limestone; characterized by abundant chert nodules and irregular layers. When free from chert this rock is one of purest limestones in State	0-250	Prominent bluff forming rock along Mississippi River from Henderson to Calhoun County; also prominent in bluffs of Illinois River in Scott, Pike, Greene and Jersey counties
		In southern part of State the Keokuk-Burlington formations are not separated but are together referred to as the Osage group which consists of massive, fine grained, dark, cherty and siliceous limestone	0-600	The Osage group is well developed in Hardin County around Hicks dome and also in Alexander County where it outcrops in the Cache River bluff northwest of Ullin
	Kinderhook	Mainly shale and sandstone with minor amounts of limestone in western part of State. In Monroe County red shale and red limestone. In southern part of State it is a green siliceous shale	25-200	In Mississippi River bluff in Pike and Calhoun counties; in Monroe County in vicinity of Valmeyer; in Union County
	Sweetland Creek	Thinly laminated green and chocolate colored shale	30-40±	Outcrops in river bluff in Pike and Jersey counties

TABLE 2.—*Generalized geologic column and description of formations in Illinois*—Continued

System	Formation	Character	Thickness	Distribution
			Feet	
Devonian	Mountain Glen	Black, fissile shale	40-400	Found in Union, Hardin and Alexander counties
	Hamilton	Northern phase is shaly and magnesian limestone in upper portion while lower portion is very fine grained, often brecciated pure limestone	125	Outcrops only in vicinity of Rock Island
		Southern phase is dark, fine grained, cherty and siliceous limestone; locally contains shale at base	100	Outcrops in Union and Alexander counties and near Grand Tower in Jackson County
	Grand Tower	Coarsely granular, very pure limestone; may locally contain shale at base	125	Outcrops only in Union and Alexander counties and near Grand Tower in Jackson County
	Dutch Creek	Coarse grained, fossiliferous sandstone	10-30	Outcrops only in Union County
	Clear Creek	Massive chert beds which locally contain thin limestone layers	300+	Makes up most of bed rock in western part of Union and Alexander counties
	Helderbergian series	Massive limestone; upper portion coarsely crystalline; lower portion thin bedded, cherty, and shaly	165	Outcrops in Mississippi River bluff in northern part of Union and southern part of Jackson counties; upper portion is exposed at south end of "Backbone" north of Grand Tower

Table 2.—*Generalized geologic column and description of formations in Illinois*—Continued

System	Formation	Character	Thickness	Distribution
			Feet	
Silurian	Niagaran series	Dolomite, massive, buff or bluish, often	0-450	Makes up bed rock in northeastern and northwestern Illinois. Outcrops for short distance in Mississippi River bluff at Grafton and in Calhoun County
	Alexandrian series	Mainly limestone, but contains some shale. Upper portion often granular and mottled pink; lower portion fine grained, dark and cherty	140±	Best exposures found in the vicinity of Thebes in Alexander County. Upper portion also exposed in Mississippi River bluff in southern Pike and Calhoun counties and in Will and Dupage counties
Ordovician	Maquoketa	Dark shale with interbedded limestone layers which are most prominent near middle portion	50-225	Outcrops co-extensively with that of the Niagaran limestone which lies immediately above; also found in southern Calhoun County
		In southern portion of the State the Maquoketa is represented by the Thebes sandstone; coarse grained sandstone with some shaly beds	75	Thebes sandstone outcrops only in vicinity of Thebes in Alexander County
	Galena-Platteville	Fine grained to granular, porous dolomite; usually buff on weathered surface. Lower beds often lighter in color, finer grained and somewhat less magnesian	300-400	Outcrops only in northern portion of Illinois

TABLE 2.—*Generalized geologic column and description of formations in Illinois*—Concluded

System	Formation	Character	Thickness	Distribution
			Feet	
Ordovician (continued)	Kimmswick-Plattin	Of approximately the same age as Galena-Platteville; upper portion a light colored, coarsely crystalline, very pure limestone; lower portion dark and fine grained	500+	Outcrops only at Thebes, Valmeyer, and in Calhoun County
	St. Peter	Moderately fine grained, uniform white sandstone	100-220	Outcrops only in northern part of State and northern Calhoun County
	Shakopee	Fine grained dolomitic and cherty limestone with interbedded layers of cement rock (shaly limestone)	10-186	Only a few scattered outcrops found in northern part of State

CHAPTER III.—SAMPLING, TESTING AND USES OF LIMESTONE ROAD MATERIALS

By J. E. Lamar

Introduction

In endeavoring to determine which of the available materials is the best suited for use as a road metal, various sets of tests, microscopic, chemical, and physical have been devised and used. If the sets of tests are to be comparable, it is obviously necessary to specify what quantity of and in what manner a sample should be obtained and used. Within recent years the manner of sampling and testing has gradually become more standardized and the methods described briefly in this bulletin are those generally accepted as a basis for the physical testing of road materials.

Method of Sampling

A sample should consist of 25 to 40 pounds of stone, composed of over 50 fragments not less than 2 inches in diameter with one piece, the core block, the size of a large brick, about 3 by 4 by 6 inches. This block of stone should be free from joints, veins or seams and should have the bedding plane clearly chiseled into it or marked on it with wax crayon or some other suitable substance. Samples may be shipped in boxes, cement sacks or other containers of similar nature, and in every case should be labelled with information concerning the sender, the place and date of shipment, and some sort of an identification number.

It is highly desirable[1] that an envelope tag be attached to the sample with the following information filled out on the card enclosed therein, or that the same information be mailed to the testing laboratory with the notification of the shipment of the sample.

The sample of limestone described below is
From the property of..
Located at ....
(Nearest town) (County) (State)
Submitted by ....
At the request of...
Date of shipment................Via.............Wt............lbs............
Approximate quantity of material available.................................
Individual identification mark..
It is desired that the sample be tested to determine its suitability as road metal.
Has this stone been used on roads? If so, where, in what type and with what results? ....

---

[1]Jackson, F. H., Methods for the determination of the physical properties of road-building rock: United States Dept. of Agri. Bulletin 347, p. 23, 1916.

Sampling from the quarry bins or loaded railroad cars is a relatively simple matter, and involves merely the selection of pieces of stone in such a manner as to be representative of the entire car or bin. A sample from a quarry however, is much more difficult to obtain and should represent the entire face both horizontally and vertically. This is accomplished by taking small pieces of rock at regular intervals both horizontally and vertically along the quarry face. Rock fragments should not be taken along joints or fault planes, nor in the immediate vicinity of the site of a heavy blast. In all these places the rock may have incipient fractures or other weaknesses which may affect the reliability of its test.

In the selection of the core block the personal equation enters in rather markedly. The block is one which is selected to represent the entire quarry face in the tests made for hardness and toughness. It should therefore, be as representative of the rock in the entire quarry as is possible.

Sampling at the quarry is easier than at an undeveloped outcrop, because in the former case the stone available to the sampler is generally fresh, sound interior rock. In the case of some outcrops which have been exposed to weathering for many years, it is necessary to break off a great many fragments of rock before the requisite amount of fresh stone is secured. In all cases, only fresh rock should be sent in for testing. Stone which has been weathered does not represent the fresh rock which it obscures, and in some cases it may be tougher, harder, and denser because of its exposure to the weather. Generally, however, the reverse is true.

Limestone which has been weathered presents a great variety of forms of which the most common probably are a dead white surface similar to a white-washed boulder, a pitted surface, a rough, granular sandy-appearing surface, and lastly a brown-stained exterior in contrast with a grey or white interior.

Purpose of Laboratory Tests

Of the various tests which it is possible to make on a limestone, the following have been adopted by the United States Bureau of Agriculture[2] as standard, and are generally accepted as such.

1. Weight per cubic foot
2. Water absorbed per cubic foot
3. Per cent of wear
4. French coefficient of wear
5. Coefficient of hardness
6. Toughness
7. Cementing value

[2]Op. cit.

Briefly the tests are made as follows:

1. *Weight per cubic foot (specific gravity).*—A representative sample of the rock, weighing about 10 grams, is thoroughly dried, weighed in air, then suspended by a silk thread from the arm of a balance and weighed in water. The weight in air divided by the loss of weight in water is the specific gravity of the stone. The specific gravity multiplied by 62.37 (the weight of a cubic foot of water on which specific gravity is based) gives the weight per cubic foot in pounds.

The weight of a cubic foot of stone is determined to make possible computations as to the weights and volumes held by various containers, such as storage bins or railroad cars.

2. *Water absorbed per cubic foot.*—A fragment of stone, weighing about 10 grams, is very carefully dried and suspended in water by a silk thread from the beam of a balance. It is weighed immediately and weighed after having been suspended in water for 96 hours. The increase in weight indicates the weight of water absorbed. By calculation, the amount of water which would be absorbed by a cubic foot of stone is determined.

The absorption test which is a measure of the amount of water a stone will absorb is of value because it indicates roughly the porosity of the stone. A highly porous stone is subject to more disruption by freezing water than a dense one because it will hold more water. In general, the disintegrating effect of frost on a stone fragment is a minor matter as compared to the destructive effect of frost on the structure of the road itself. However a stone which is otherwise a satisfactory road material is not likely to be rejected if it has a high porosity.

3. *Per cent of wear.*—From 40 to 60 pieces of stone, weighing 5,000 grams, are placed in a steel cylinder with its axis inclined 30 degrees from the axis of rotation which is horizontal. The cylinder is rotated 10,000 times at the rate of 30 rotations per minute. At the completion of the specified rotations, the sample is screened and washed on a 1/16-inch mesh sieve. The material not passing the seive is dried and weighed, and the per cent of wear calculated as follows:

$$\text{Per cent of wear} = \frac{5000 - \text{the weight of the material not passing the seive}}{5000} \times 100$$

4. *French coefficient of wear.*—The French coefficient of wear is determined by dividing 40 by the per cent of wear obtained as described above.

In making the test for the per cent of wear from which the French coefficient is derived the sample is thrown from one end to the other of the containing cylinder twice in each revolution. This brings about impact and abrasion of one stone upon another, upon the sides of the cylinder itself, nearly similar to the kind of wear imposed upon the stones under motor traffic, except for the fact that in the latter case the abrasion probably takes place under a somewhat greater pressure than in the laboratory tests. Another virtue of this test, according to Clarke[3] is that the average per cent of wear for the rock in a given unit of a quarry face does not vary more than the liable error of 0.2 caused by laboratory procedure. The per cent of wear or French coefficient, therefore, is one fairly dependable basis of comparing road materials, and is coming more and more to be considered the most important physical test made on road materials, so much so that the only specifications made in many states is that stone used in highway construction be clean, unweathered, of a certain size and have a French coefficient of more than a certain minimum. In Illinois the specifications require a stone testing more than 5 for a broken stone pavement, and more than 6 for a concrete pavement.

5. *Coefficient of Hardness.*—In determining the coefficient of hardness a cylinder 25 millimeters in diameter and 10 centimeters long is cut from the core block by means of a diamond core drill. This cylinder, under an initial load of 1250 grams, is subjected to abrasion by quartz sand on a revolving metal disk. The sand used is of such size that it passes a 30-mesh screen but is retained on a 40-mesh screen. The specimen is held by a metal sleeve which allows it vertical but no horizontal play and whose center is 26 centimeters from the center of rotation of the disk. The coefficient of hardness is computed by subtracting ⅓ of the loss of weight after 1000 revolutions of the disk, from 20.

The hardness test is made for the purpose of determining the ability of a rock to withstand frictional wear. It may probably be eliminated from the set of physical tests, however, since recent work[4] has demonstrated that hardness is so closely related to toughness that if a stone is suitably tough it will also be sufficiently hard to make an acceptable road material.

6. *Toughness.*—Page[5] has defined toughness as the power possessed by a material to resist fracture when subject to impact. In determining this property a cylinder of rock 25 millimeters in diameter and 25 millimeters long, cut from the core block, is subjected to the impact of a 4.4 pound or 2 kilogram weight, which delivers its blow upon a steel plunger, one end of which is hemispherical and in contact with the rock cylinder. The fall of the weight is increased one centimeter or about two-fifths of an inch after each blow. When the test piece breaks, the height in centimeters of the blow

[3]Reinecke, L., and Clark, K. A., The sampling of deposits of roadstone and gravel in the field: Proc. Amer. Soc. Test. Materials, Vol. XVIII, Part II, 1918.

[4]Hubbard, Prevost, and Jackson, F. H., Jr., The relation between the properties of hardness and toughness of road building rock: Jour. Agri. Research, vol. 5, No. 19.

[5]Page, L. W., Road materials and their physical properties: 7th Ann. Rept. Mass. Highway Comm., pp. 67, 70, Jan. 1900.

producing the failure is known as the toughness. This test is made to determine how a stone will withstand the shock and impact of wheels and tires of heavy and light vehicles and of horses' hoofs. From the fact that the test is made on a single block of stone actually representing at best a few feet of a rock exposure, it is obvious that the toughness tests from any quarry may vary considerably. The Niagaran dolomite at Joliet has a toughness ranging from 5 to 13, at Thornton from 6 to 10, at Elmhurst from 6 to 10, at Kankakee from 4 to 10, and at the Lehigh quarry from 5 to 7. The Burlington limestone at Quincy varies between 5 and 9. Despite the evident variation however, if due consideration is taken in sampling to obtain core blocks representative of the different sorts of stone, an approximate average may be obtained for the quarry.

7. *Cementing value.*—About 500 grams of the rock sample are crushed to about pea size and then given 5,000 revolutions in a ball mill at the rate of 30 per minute. The resulting paste is then pressed into briquettes 25 millimeters in diameter and 25 millimeters high, in a molding machine which applies the same pressure to each briquette. The briquettes are dried at room temperature for 20 hours and then placed in an impact machine in which they are subjected to the blow of a 2.2 pound or 1-kilogram hammer, which falls through a constant height of 1 centimeter. The blow of the hammer is transmitted to the briquette through a ½-kilogram plunger. The number of blows necessary to produce failure of the briquette is known as the cementing value of the stone from which the briquette was made.

The test for cementing value is made to determine the binding power of a stone when ground to a powder, wetted, pressed and dried. The actual binding power of a rock powder when acted upon by water is ascribed by Cushman[6] to the formation of a colloidal gel with properties similar to artificially coagulated colloids. The drying of the powder and colloidal matter and the accompanying loss of water result in the formation of a more or less solid mass.

In a water-bound macadam road, particularly, the fragments of stone are continually rubbing on one another when subjected to traffic, thereby producing rock powder in addition to that already in the road. When the rock powder in the road becomes wet and later dries, the binding power of the powder tends to make the road a relatively solid mass. A determination of the cementing value therefore is essential if the stone being tested is to be used for a water-bound macadam road.

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[6]Cushman, A. S., The effect of water on rock powders: U. S. Dept. of Agri. Bur. Chemistry Bull. 92, p. 12.

ADDITIONAL REFERENCES ON SAMPLING AND TESTING

Hotchkiss, W. O., and Steidtmann, E., Limestone road materials of Wisconsin: Wisconsin Geol. Survey Bull. XXXIV, p. 11, 1914.

Hubbard, H., and Jackson, F. H., The results of physical tests of road-building rock: U. S. Dept. of Agri. Bull. 370, 1916.

Hubbard, P., and Jackson, F. H., Typical specifications for non-bituminous road materials: U. S. Dept. of Agri. Bull. 704, 1918.

Jackson, F. H., Methods for the determination of the physical properties of road-building rock: U. S. Dept. of Agri. Bull. 347, 1916.

Reinecke, L., Non-bituminous road materials: Economic Geology, vol. XIII, no. 8, p. 557, Dec. 1918.

Standard forms for specifications, tests, reports, and methods of sampling for road materials: U. S. Dept. of Agri. Bull. 555, 1917.

General Value of Road Material Tests

The purpose of the physical tests made on road materials is to forecast if possible the manner in which a stone will react to and withstand the agencies or processes which tend to destroy it. Of these the two most active are mechanical abrasion (traffic) and temperature changes (climate). By the former is meant the effect of the impact and abrasion by tires, wheels, steel-shod hoofs and the erosion by water running from the surface of the road, while the latter involves heating and cooling with disruption from unequal expansion and contraction, and the wedging effect of freezing water. These, aided by chemical decomposition and the activities of growing organisms, tend to tear down and destroy a road.

It is very true that the real test of any road material is the actual service it gives when in the road. Such a test is the only conclusive one, regardless of what results the stone shows in the laboratory. Though there may be discrepancies between the laboratory tests and the actual results obtained in the road, however, the tests are not without their value, for they indicate in a general way what rock is to be avoided and what is likely to be suitable.

When it is considered that limestones change markedly within comparatively short distances both vertically and horizontally and that in all probability no two samples taken from the same quarry by different individuals would test the same, it is obvious that a single analysis cannot represent an outcrop except in a general way. If however, a series of samples are obtained from a given quarry, their average will represent the stone with a fair degree of accuracy. Figure 3 represents the French coefficient of a number of samples of limestone and dolomite taken from the same quarry or the same given region. It is interesting to note how closely the high and low points of the graphs respectively coincide. In the graph of the Thornton quarry 9 and 5.3 are the maximum and minimum French coefficient values; in that of the Joliet stone 10.8 and 6.8, and in that of the Lehigh stone 10.8 and 7.5.

The general similarity of the high and low tests respectively may be due to the fact that the high testing samples were obtained from a more resistant layer in the quarry and the low testing samples from a softer layer. In such a case the samples yielding intermediate tests may be a mixture of the two. Another explanation might be that the stone in one part of the quarry without regard to layers, is more resistant than in the other parts.

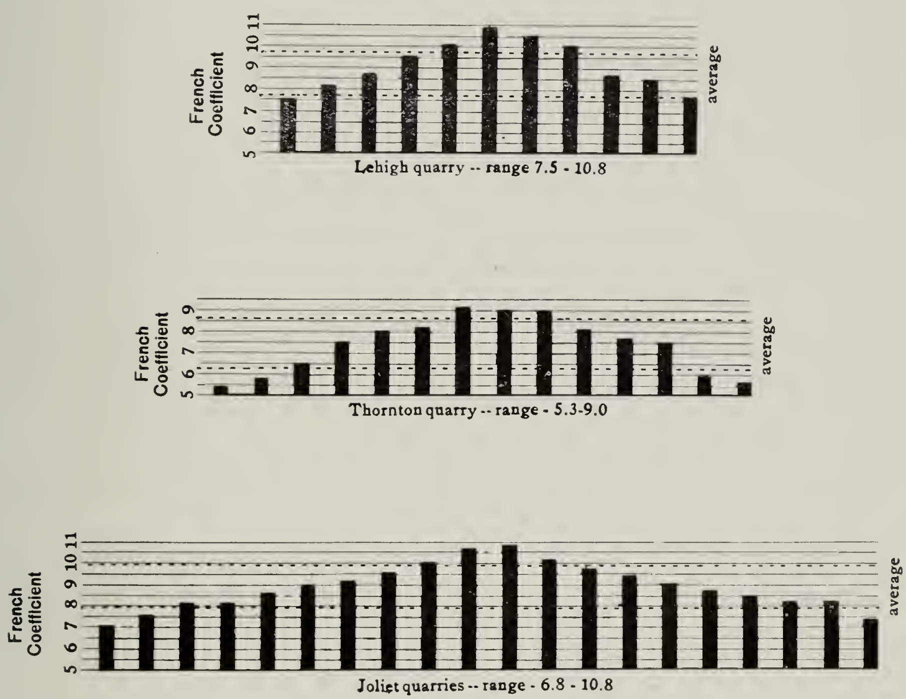


FIG. 3. Graph showing the variation of the French coefficient of Niagaran dolomite as indicated by tests from certain quarries and unit areas.

The value of a single sample as representing the rock of an entire outcrop is therefore somewhat doubtful. Too many variable factors enter into its choice. If, however, a group of samples is obtained from different outcrops of the same formation within a restricted locality, it is possible to arrive at a general idea as to what the formation as a whole will test. Having established this general average, and if it is found to be satisfactory, other tests from samples taken at selected points from the same geological formation would aid in the choice of a desirable quarry site.

Evaluation of Results of Tests

It is customary in describing road materials to consider them as having high, low, or medium tests, and for this purpose certain scales of values have been constructed. Hotchkiss gives the following scale of values for the properties of road materials, deriving his data from tests on limestone and other rocks.[7]

	Low	Medium	High
French coefficient of wear	Below 8	8-13	14-20 (above 20 very hard)
Hardness	Below 14 (soft)	14-17	Above 17 (hard)
Toughness	Below 13	13-19	Above 19
Cementing value	Below 10	10-25 (fair)	26-75 (good) 76-100 (very good) Above 100 (excellent)

The Office of Public Roads has made tests on some 800 samples of limestone and 350 samples of dolomite obtained from various parts of the United States. The averages of their results are as follows:[8]

Average hardness	15
Average toughness	7
Average French coefficient	8
Cementing value—75 per cent of samples over 25	
Average specific gravity	2.7 (range 2.6-2.85)
Average weight per cubic foot in pounds	
Limestone	168
Dolomite	170
Range	160-178
Absorption varies from a few hundredths of 1 per cent to 13 per cent.	

From a comparison of these two tables it would appear that the average limestone or dolomite as compared with rocks in general is of medium hardness, low toughness, barely medium French coefficient and good cementing value. However as limestone and dolomite are the only rocks quarried in Illinois for road material, it seems desirable that a scale of values be constructed which will make possible a comparison of the tests of specific limestones and dolomites with reference to these rocks as a group. The accompanying graphs (figs. 4 a and b) made from the results of the tests on

[7]Hotchkiss, W. O. and Steidtman, E., Limestone road materials of Wisconsin: Wis. Geol. Survey Bull. XXXIV, pp. 11-14, 1914.

[8]Hubbard, P. and Jackson, F. H., The results of physical tests of road-building rock: U. S. Dept. Agriculture Bull. 370, p. 6, 1916.

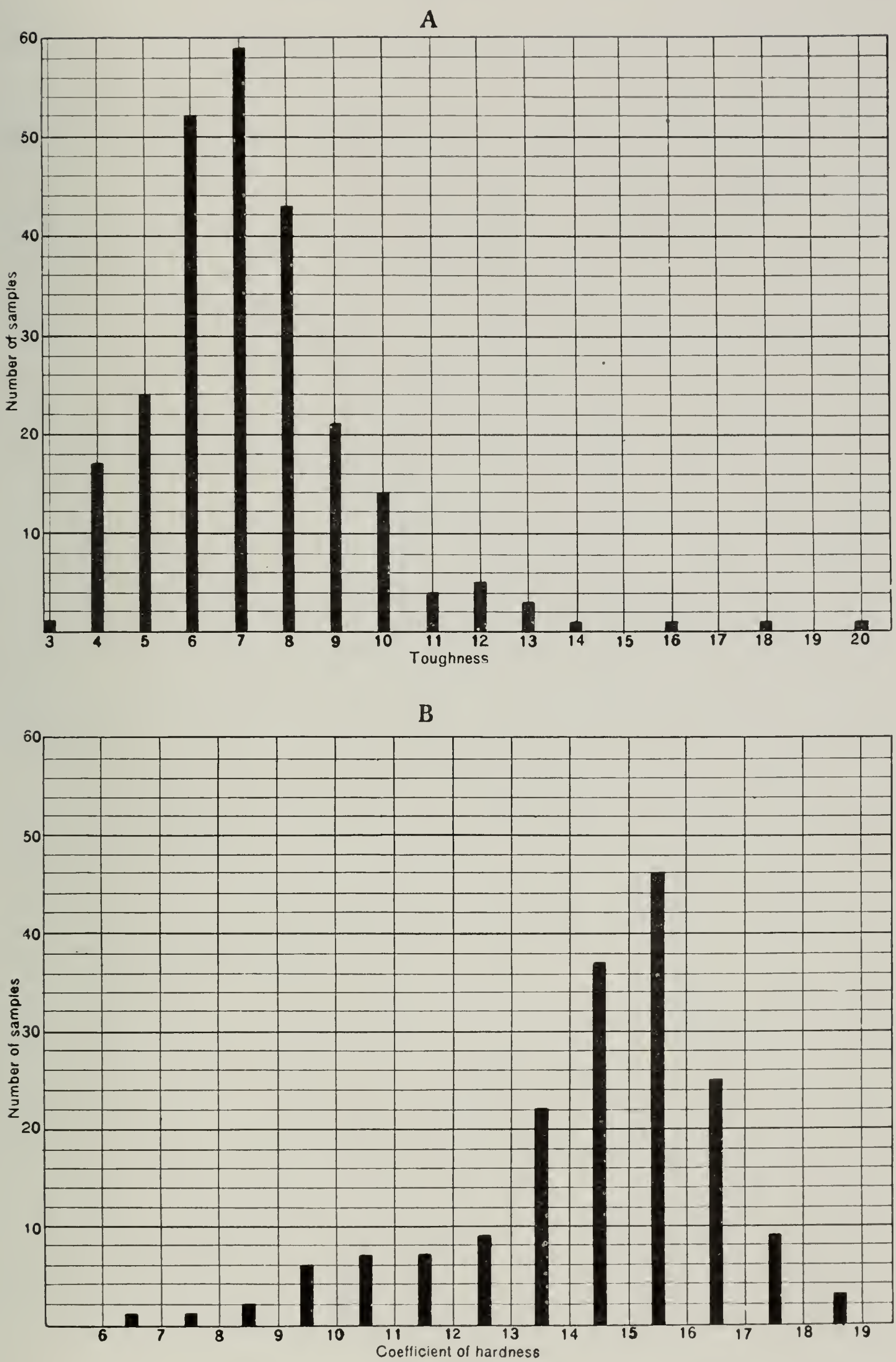
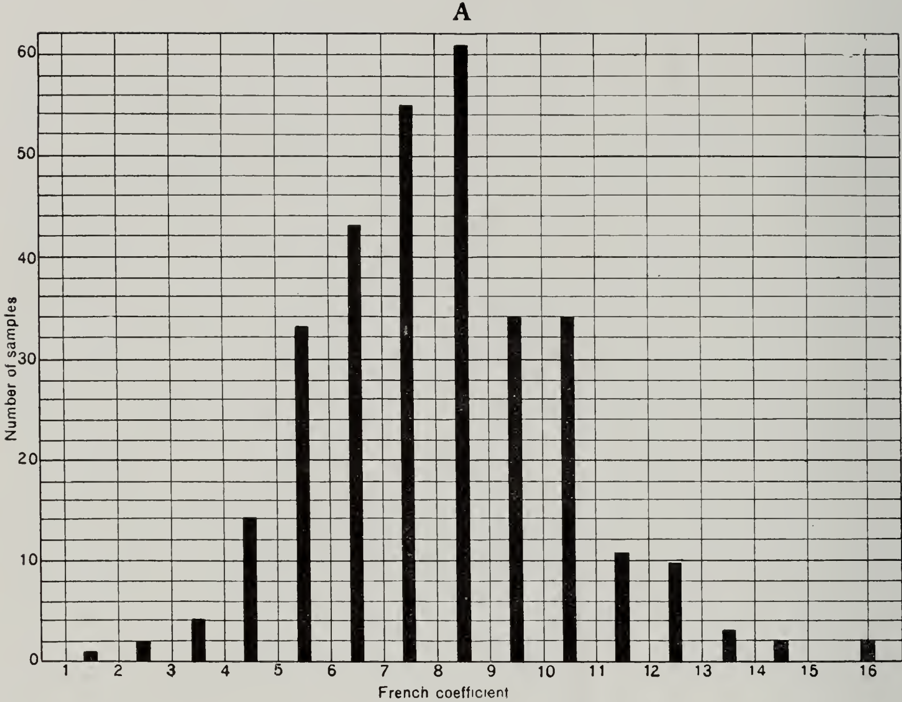


Fig. 4a. Graphs showing the variation in toughness (248 samples) and hardness (176 samples) in Illinois limestones and dolomites.

A		B	
Low..........	Less than 6	Low..........	Less than 13
Medium.......	6-8	Medium.......	13-17
High.........	Above 8	High.........	Above 17
Average......	7.3	Average......	14.5



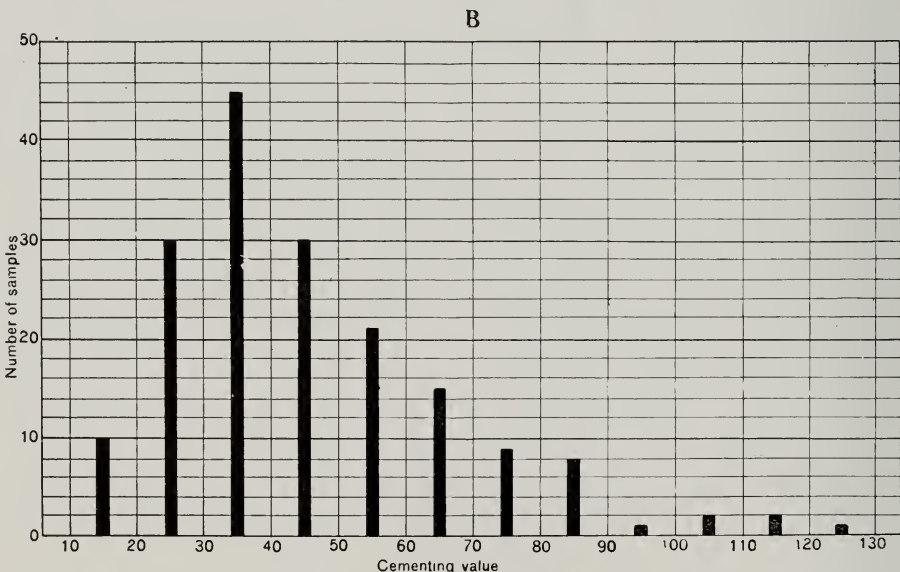


FIG. 4b. Graphs showing the variations in the French coefficients (307 samples) and cementing values (172 samples) in Illinois limestones and dolomites.

A		B	
Low..........	Less than 5	Low..........	Less than 20
Medium.......	5-11	Medium......	20-50
High.........	Above 11	High.........	Above 50
Average......	8.1	Average......	52.3

Illinois limestones and dolomites (see Table 5) suggest the following scale of values for limestones and dolomites as a group.

	Low	Medium	High	Average
French coefficient (307 samples)......	Less than 5...	5-11	Above 11..	8.1
Hardness (176 samples)............	Less than 13..	13-17	Above 17..	14.5
Toughness (248 samples)...........	Less than 6...	6-8	Above 8...	7.3
Cementing value (181 samples).......	Less than 20..	20-50	Above 50..	52.3

According to the above scale of values, the average Illinois stone has a medium French coefficient, hardness, toughness, and a high cementing value. The average cementing values as stated in the above table however, include 13 samples of stone testing over 100. If these samples are omitted from the computation, the average cementing value for the remaining samples is 42.7.

General Requirements of Limestone and Dolomite Used in Various Types of Roads

In discussing the physical properties of road-building rock, it is necessary to consider the type of road in which the stone is to be used, because different types of roads require different qualities of stone.

WATER-BOUND MACADAM ROADS

Since the innovation of the automobile to common use, the water-bound macadam has been gradually losing favor. Such a road gives good service for horse drawn vehicles, but when subject to automobile traffic it ruts rapidly and develops numerous small depressions. A water-bound macadam road depends for its durability chiefly on the cementing value, or binding power of the smaller bits of stone or dust. The shearing action of the tires and the air movements set up by the motion of the vehicle remove this binding dust, resulting in a rapid failure of the road. Furthermore when the small depressions in the road become filled with water after a shower or during the spring thaws, an automobile wheel traveling at a high rate of speed splashes the water and finer stone out of the hole, causing an enlargement of the depression and the loss of a certain amount of binder.

It is obvious then that above all, stone for water-bound macadam roads should have a high cementing value in order to bond well in the road and to minimize the loss of dust and fine material from the effects of traffic. At the same time the French coefficient of wear must be low enough to permit the formation of sufficient fine material to compensate for dust losses incurred by the road. In general a cementing value over 25 is considered desirable.[9]

[9]Hubbard, P. and Jackson, F. H., The results of physical test of road-building rock: U. S. Dept. Agriculture Bull. 370, 1916.

Recommendations for French coefficient, per cent of wear, toughness and hardness for light, moderate and heavy traffic are given in Table 3. The recommendations for the per cent of wear and toughness of rock for light traffic are from three different sources, the first from the Office of Public Roads, the second from the American Society of Municipal Improvements and the third from the American Society of Civil Engineers.

Table 3.—*Limiting values of physical tests of rock for water-bound macadam roads according to the amount of traffic*

Character of traffic	Limit of tests			
	French coefficient	Per cent of wear	Toughness	Hardness
Light (less than 100 vehicles daily)[9]	5-8	5-8	5-9	10-17
Light (less than 100 vehicles daily)[10]	....	5.7 and under	6 and over	....
Light (less than 100 vehicles daily)[11]	....	5 and under	6 and over	....
Moderate (100-250 vehicles daily)[9]	8-15	2.7-5	10-18	Over 14
Heavy (over 250 vehicles daily)[9]	Over 15	Less than 2.7	Over 18	Over 17

BITUMINOUS ROADS

The binder for bituminous roads is bituminous material which is intimately mixed with the materials composing the road or is spread over the top of the road as a surfacing or carpet. For this type of road a stone is desired with a relatively high French coefficient of wear and of sufficient porosity to admit some of the bitumen into the surface pores. This permits partial impregnation of the rock fragments and results in a greater cohesion of the materials of the road as a whole. Relatively high toughness and hardness values are also desirable.

The minimum limits of physical tests of rock for bituminous road construction, are given in the following table. It is to be noted that the recommendations for stone to be used in bituminous concrete are obtained from different sources as indicated.

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[9]Hubbard, P. and Jackson, F. H., The results of Physical tests of road-building rock: U. S. Dept. Agriculture Bull. 370, 1916.

[10]Recommended by American Soc. of Municipal Improvements, 1914.

[11]Recommended by American Soc. of Civil Engineers, 1917.

TABLE 4.—*Limiting values of physical tests of rock for bituminous roads according to the amount of traffic*

Type of road	Character of traffic	French coefficient	Per cent of wear	Toughness
Broken stone with a bituminous carpet	Light to moderate.	5	Not over 8 [9]...	5
Bituminous broken stone with seal coat............	Moderate to heavy.	7	Not over 5.7 [9].	10
Bituminous concrete with or without seal coat.........	Light to moderate.	7	Not over 5.7 [9].	7
Bituminous concrete with or without seal coat.........	Light to moderate.	....	3.5 [10]	Over 13
Bituminous concrete with or without seal coat.........	Light to moderate.	....	Less than 3.5 [11]	Over 13
Bituminous concrete with or without seal coat.........	Moderate to heavy.	10	Not over 4 [9]...	13
Bituminous concrete with or without seal coat.........	Moderate to heavy.	....	Less than 3.5 [10]	Over 13
Bituminous concrete with or without seal coat.........	Moderate to heavy.	....	Less than 3.5 [11]	Over 13

PORTLAND CEMENT CONCRETE ROADS

This type of road is monolithic and is practically free from internal wear such as occurs in a macadam road. The stone in a concrete road, however, should be somewhat harder than the cement which binds it. A minimum hardness of 12 for moderate traffic and of 16 for heavy traffic, and a toughness of 8 or over are recommended[12] by the United States Office of Public Roads. As regards the French coefficient, the Illinois State Highway Department specifies that the stone have a French coefficient of 6 or over. Other authorities variously recommend a minimum French coefficient of from 6 to 10. Some porosity is not objectionable since a penetration of the cement into the surficial pores of the stone serves to make stronger the bond between the two.

ADDITIONAL PROPERTIES OF ROAD METAL WARRANTING CONSIDERATION

TEXTURE

It is essential in the selection of a stone for use in highway construction that it be of uniform texture throughout the quarry. By this is meant

[9]Hubbard, P. and Jackson, F. H., The results of physical tests of road-building rock: U. S. Dept. Agriculture Bull. 370, 1916.

[10]Recommended by American Soc. of Municipal Improvements, 1914.

[11]Recommended by American Soc. of Civil Engineers, 1917.

[12]Hubbard, P. and Jackson, F. H., The results of physical tests of road-building rock: U. S. Dept. Agriculture Bull. 370, 1916.

a "uniformity in size, closeness and manner of contact of constituent grains."[13] Textural differences result in difference in hardness, toughness, porosity, and French coefficient. It is therefore obvious that if a road is to retain a smooth or even surface under traffic, it must be constructed of stone of the same texture which will wear equally throughout under a given set of conditions.[14]

COLOR

The color of a fresh rock generally has little, if any, effect upon its desirability for road use. There seems to be a general prejudice against a buff-colored stone, because of its supposed inferiority to white stone. However, numerous tests bear out the fact that some brown and buff limestones and dolomites are superior to the white or blue stone in the same bed or formation. The buff or brown color is usually due to the deposition of hydrated iron or rust in the interstices of the stone. The effect is to decrease the porosity and thereby increase the strength of the rock.

DELETERIOUS MATERIALS

PYRITE

Among the most common minerals occurring in stone used for road purposes is pyrite or marcasite, the sulphide of iron, commonly known as fool's gold. Upon weathering, it forms iron hydroxide or rust which occupies a greater volume than did the original pyrite. This tends to produce expansion in the rock, which may relieve itself by the cracking or "scaling off" of the stone, making pits and planes of weakness. While pyrite might not be particularly harmful in macadams, it should be avoided in stone to be used in concrete roads.

SHALY PARTINGS AND CHERT

Shaly partings in a rock, however small, constitute planes of weakness which though they may not be of great importance or be noticeably objectionable when the stone is first placed on the road, will after a period of weathering become fracture planes or planes of failure.

Chert is objectionable for use with limestone or dolomite in a concrete road, because it is much harder than the limestone or the cement surrounding it, and therefore is more wear resisting and has a tendency to stand up as small bosses in the road after the road has become somewhat worn. Further, it has a different rate of expansion and contraction than limestone or dolomite, and for that reason when subjected to extremes of temperature sets up either tensional or compressional strains in the road with a resulting tend-

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[13]Buckley, E. R., Building and ornamental stones of Wisconsin: Bull. Wisconsin Geol. and Nat. Hist. Survey No. IV, p. 40, 1898.

[14]Shoop, C. F., An investigation of concrete road-making properties of Minnesota stone and gravel: Bull. Univ. of Minnesota, Studies in Engineering, No. 2.

ency to weaken it. This effect is probably very minor, however. In a bituminous macadam, its greatest objection is its superior hardness which makes it stand up in the road as small knobs. It is valueless in a water-bound macadam except that it acts as an abrasive on the limestone and produces small fragments of the latter which serve as a binder. The chert itself, however, does not form a binder nor does it generally offer a surface which is rough or porous enough to be firmly adhered to by a cement.

Chert is however satisfactorily used in roads in the case of the so-called "novaculite" gravel of southern Illinois. The chert occurs interbedded with thin layers of clay which serves as a binder when the material is put on the road.

CHAPTER IV.—PHYSICAL PROPERTIES OF ILLINOIS LIMESTONES AND DOLOMITES

By J. E. Lamar

Introduction

Table 5, pages 47-62, has been compiled from various sources and includes all the physical analyses of Illinois limestones heretofore published by the Illinois or United States Geological surveys, with additional tests made by the Illinois Highway Testing Laboratory on samples taken in connection with the investigation of road materials in Illinois. The analyses are grouped by counties and descriptions of these materials arranged by counties may be found in Chapters VII to X.

Relations of Physical Tests to Each Other

It has been shown[1] that there is a definite relation between hardness and toughness, such that a stone of sufficiently high toughness to be a satisfactory road material will also generally give a satisfactory test for hardness. The accompanying graph (fig. 5) bears out this relation, and it will be seen that for each formation except for the Maquoketa in Kankakee County the ratio of hardness to toughness is very similar.

Another relation between physical tests of interest is that with the exception of the Menard limestone, the French coefficient and toughness increase or decrease alike but not to the same degree. Seventeen formations have a toughness of medium or better, and sixteen a French coefficient of medium or better. The Shakopee dolomite falls below medium for the French coefficient.

There is no apparent relation between the cementing value and any of the other physical tests.

Relation of Physical and Chemical Properties to Physical Tests

From the table of average tests, Table 6, for the various formations four general conclusions may be drawn:

1. Coarsely crystalline limestones have a low-medium or low French coefficient if they are pure. As examples, may be cited the Burlington, Maquoketa, Kimmswick, and Salem limestones.

[1]Hubbard, Prevost, and Jackson, F. H., Relation between the properties of hardness and toughness of road-building rock: Jour. Agr. Research, vol. 5, No. 19, Feb. 7, 1916.

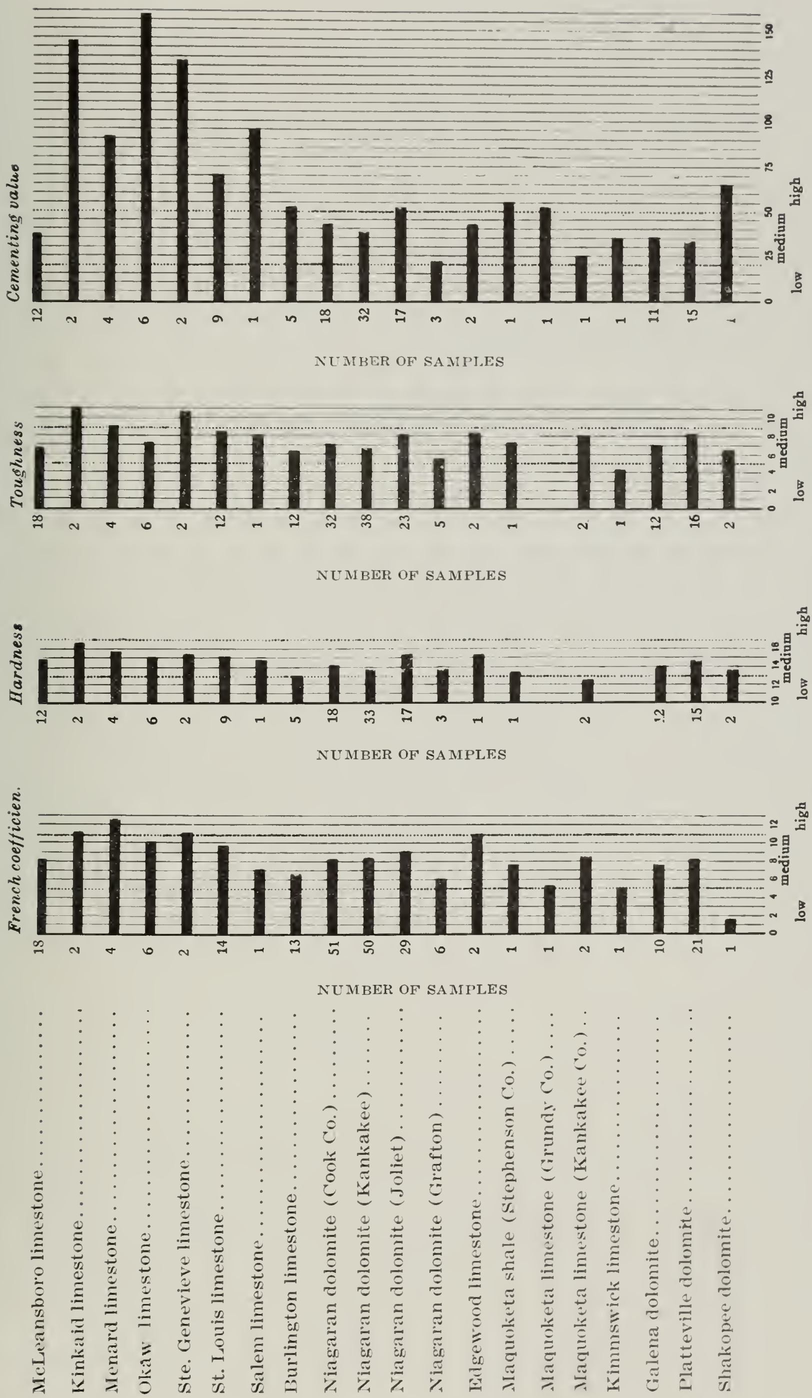

FIG. 5. Graph showing the physical properties of Illinois limestones and dolomites by formations.

2. Fine- and medium-grained dense limestones have a high-medium or high French coefficient. As examples, may be cited the Menard, Kinkaid, St. Louis, Ste. Genevieve, and Edgewood limestones.

3. The dolomites, the Niagaran and Galena, are medium grained, and show a medium French coefficient close to the mean for all formations.

4. Lord[2] has pointed out that "limestones containing an appreciable amount of quartz with some kaolin or clay are tougher and have lower percentages of wear (higher French coefficient) and higher cementing values than samples deficient in these minerals". This obtains in general for many Illinois limestones which contain disseminated siliceous and argillaceous material, but is not without exceptions.

[2]Lord, E. C. E., Relation of mineral composition and rock structure to the physical properties of road materials: U. S. Dept. Agriculture Bull. 348, p. 19, 1916.

Table 5.—*Results of physical tests on Illinois limestones and dolomites*

County	Reference No.	Location	Company	Specific gravity	Wt. per cu. ft.	Absorption: Per cent	Absorption: Lbs. per cu. ft.	Per cent of wear	Coefficients: French	Coefficients: Hardness	Coefficients: Toughness	Cementing value	Remarks
Alexander[a]	437	Elco			156		3.30	5.9	6.8			12	Chert
	584	Elco			150		4.13	2.7	14.6			5	Chert
	1443	Ullin (near)			162		.50	5.8	6.9	19.4	7	15	Cherty limestone (Osage?)
	7148	Olive Branch			150		1.69	12.0	3.3				Chert
Adams	1522	Quincy			165		1.66	7.6	5.3	10.6	6	46	Burlington
	2396	Quincy			168		1.01	6.0	6.6	13.2	6	37	Burlington
	2397	Quincy			168		.51	5.3	7.8	12.7	5	67	Burlington
Adams[b]	3707	Old quarry in Adams County	L. L. Boyer, County, Supt. of Highways, Quincy, Ill.	2.65	165		1.0	5.8	6.9		7		Burlington
	910	Quincy	F. W. Menke Stone Co.	2.54	158		2.2	5.5	7.3		6		Burlington
	914	Quincy	Wm. D. Meyer Stone Co.	2.63	164		1.0	7.7	5.2		6		Burlington
	932	Quincy	Wm. D. Meyer Stone Co.	2.61	163		1.9	7.2	5.5		6		Burlington
	933	Quincy	F. W. Menke Stone Co.	2.60	162		2.0	6.9	5.8		6		Burlington
	1944	Quincy	Marblehead Lime Co.	2.66	166		1.32	6.3	6.3		9		Burlington
Boone[b]	1548	Garden Prairie	C. L. Tryon, Woodstock	2.66	166		2.80	7.2	5.5		8.0		
	1598	Garden Prairie	C. L. Tryon, Woodstock	2.82	176		0.44	5.5	7.3		9.0		
	1897	Belvidere	Boone County Electric Stone Co., Belvidere	2.71	169		1.88	6.8	5.9		7		Galena
Boone[c]	L 276	NE. ¼, sec. 34, T. 44 N., R. 3 E.	Belvidere Crushed Stone Co.	2.65	165	1.9	3.14		6.8	15.7	7	30	Galena
Carroll[c]	L 315	NE. cor. sec. 4, T. 24 N., R. 3 E.		2.39	150	1.2	1.80		1.4		7	39	Niagaran
	L 316	SE. cor. sec. 28, T. 25 N., R. 3 E		2.71	169	2.1	3.5		6.0	16.8	5	33	Niagaran
	L 317	SW. ¼, sec. 18, T. 14, N., R. 4 E		2.67	167	1.1	1.84		6.7	15.0	7	20	Galena (?)
Calhoun[b]	1168		M. W. Watson, Springfield, Illinois	2.67	166		0.67	6.1	6.6		7.0		
	1478		J. A. Earley, Batchtown, Illinois	2.67	166		0.83	7.6	5.2		5.0		Kimmswick
	3151	1,000 feet south of Station 94, sec. B	S. F. Wilson, Hardin, Ill.	2.65	165		1.25	5.7	7.0		8		Burlington (?)
Clark[a]	2391	Marshall			165		.91	3.7	10.8	14.8	5	31	Mcleansboro

TABLE 5.—*Results of physical tests on Illinois limestones and dolomites*—Continued

County	Reference No.	Location	Company	Specific gravity	Wt. per cu. ft.	Absorption: Per cent	Absorption: Lbs. per cu. ft.	Per cent of wear	Coefficients: French	Coefficients: Hardness	Coefficients: Toughness	Cementing value	Remarks
	2392	Casey	......	......	168	......	.68	5.2	7.7	15.7	4	33	McLeansboro
	5846	Casey	......	......	168	......	.64	4.8	8.3	15.0	8	49	McLeansboro
Clark[b]	1420	Casey	A. & C. Stone & Lime Co., Greencastle, Indiana	2.68	167	......	0.80	4.5	8.9	......	......	......	McLeansboro
	2035	West Union	Farmers Limestone Milling Co., Robinson, Ill.	2.71	169	......	0.60	3.7	10.8	......	12	......	Sample from ledge 7 feet deep
	1043	Robinson	Farmers' Limestone Milling Co.	2.68	167	......	1.9	5.7	7.0	......	8	......	Top layer-McLeansboro
	1044	Robinson	Farmer's Limestone Milling Co.	2.71	169	......	0.63	5.4	7.4	......	10	......	Bottom layer-McLeansboro
Coles[a]	4422	Embarrass	......	......	168	......	1.42	4.2	9.5	14.2	6	40	McLeansboro
	7615	Loxa	......	......	168	......	.43	4.8	8.3	15.0	7	38	McLeansboro
Cook[a]	716	Chicago	......	......	168	......	.58	4.4	9.1	......	......	30	Niagaran
	756	Chicago	......	......	168	......	.86	5.8	6.9	......	......	......	Niagaran
	4126	......	......	......	172	......	.84	6.0	6.6	15.1	8	34	Niagaran
	5509	Thornton	......	......	162	......	2.15	4.9	8.2	13.5	7	16	Niagaran
	5755	Thornton	......	......	156	......	4.44	5.3	7.5	13.0	6	128	Niagaran
	6053	Thornton	......	......	172	......	1.02	6.1	6.6	12.7	7	24	Niagaran
	7737	......	......	......	168	......	.88	5.1	7.9	16.0	11	26	Niagaran
	7739	Bellewood	......	......	168	......	2.11	4.5	8.9	15.8	9	37	Niagaran
	7754	Thornton	......	......	168	......	1.68	4.5	8.9	13.9	10	27	Niagaran
	7768	Chicago	......	......	172	......	.76	4.8	8.3	15.8	10	40	Niagaran
	7733	Chicago	......	......	168	......	.99	4.2	9.5	13.8	7	34	Niagaran
	8069	La Grange	......	......	168	......	1.59	6.5	6.1	16.0	6	32	Niagaran
	8147	......	......	......	162	......	1.53	4.9	8.1	13.0	6	46	Niagaran
	8711	Hillside	......	......	162	......	3.97	4.2	9.5	14.7	4	110	Niagaran
	8097	......	......	......	168	......	.56	4.7	8.5	6.5	4	52	......
	7374	......	......	......	162	......	4.65	4.7	8.5	11.3	5	33	Niagaran
Cook[b]	578	Chicago	Chicago Union Lime Works	2.75	171	......	2.60	3.7	10.8	......	......	......	Niagaran
	587	Gary	Dolese & Shepard Co.	2.78	173	......	0.94	3.9	10.2	......	......	......	Niagaran

589	La Grange	Superior Stone Co.	2.61	163	......	3.5	5.8	6.9	......	......	......	Niagaran
605	McCook	U. S. Crushed Stone Co.	2.75	171	......	1.14	5.7	7.0	......	6	......	Niagaran
673	Thornton	Brownell Improvement Co.	2.69	168	......	2.2	5.8	6.9	......	......	......	Niagaran
709	McCook	U. S. Crushed Stone Co.	2.70	168	......	1.8	5.1	7.9	......	9	......	Niagaran
710	McCook	U. S. Crushed Stone Co.	2.70	168	......	1.0	6.3	6.4	......	7	......	Niagaran
711	McCook	U. S. Crushed Stone Co.	2.75	172	......	0.8	5.6	7.2	......	8	......	Niagaran
720	Thornton	Brownell Improvement Co.	2.65	165	......	1.5	5.3	7.5	......	7	......	Niagaran
724	McCook	U. S. Crushed Stone Co.	2.68	167	......	1.6	5.5	7.3	......	......	......	Niagaran
739	Lyons	Riverside Lime & Stone Co.	2.50	156	......	3.4	6.0	6.7	......	7	......	Niagaran
754	Bellewood	A. C. O'Laughlin Stone Co	2.61	163	......	3.4	5.0	8.0	......	......	......	Niagaran
761	Blue Island	Franklin Stone Co.	2.65	165	......	2.6	4.6	8.7	......	......	......	Niagaran
762	Lemont	Illinois Stone Co.	2.65	165	......	1.8	4.1	9.8	......	5	......	Niagaran
785	Riverside	Riverside Lime & Stone Co.	2.65	165	......	2.4	4.9	8.2	......	......	......	Niagaran
883	McCook	U. S. Crushed Stone Co.	2.67	167	......	1.2	4.8	8.3	......	......	......	Niagaran
924	Lemont	Universal Crushed Stone Co.	2.74	171	......	0.53	5.4	7.4	......	......	......	Niagaran
1842	Thornton	Brownell Improvement Co. Chicago	2.61	163	......	3.43	4.5	8.8	......	7	......	Niagaran
2219	Thornton	Brownell Improvement Co. Chicago	2.71	169	......	0.63	6.8	5.9	......	......	......	Material used as coarse stone. Sec. C, Iroquois County
3027	Thornton	Brownell Improvement Co. Chicago	......	......	......	......	5.4	7.4	......	......	......	80 pieces required for abrasion test instead of standard 50 pieces.
3028	Thornton	Brownell Improvement Co. Chicago	......	......	......	......	4.5	8.9	......	......	......	67 pieces required for abrasion test instead of standard 50 pieces.
3112	Thornton	Brownell Improvement Co. Chicago	......	......	......	......	5.0	8.0	......	......	......	85 pieces required for abrasion test instead of standard 50 pieces.

TABLE 5.—*Results of physical tests on Illinois limestones and dolomites*—Continued

County	Reference No.	Location	Company	Specific gravity	Wt. per cu. ft.	Absorption: Per cent	Absorption: Lbs. per cu. ft.	Per cent of wear	Coefficients: French	Coefficients: Hardness	Coefficients: Toughness	Cementing value	Remarks
	3171	Thornton	Brownell Improvement Co. Chicago	2.61	163	......	3.0	7.0	5.7	......	7	......	Material used as first coarse stone Sec. C, Iroquois County
	3217	Thornton	Brownell Improvement Co. Chicago	2.66	166	......	......	5.0	8.0	......	9	......	57 pieces taken for abrasion test Sample from G. A. Quinlin, Chicago.
	3282	Thornton	Brownell Improvement Co. Chicago	2.60	162	......	2.08	5.5	7.3	......	7	......	Sample received from F. C. Fuetz, Danville, Illinois.
Cook	3545	Bellewood	A. C. O'Laughlin Co., Chicago, Ill.	2.67	166	6.6	2.37	......	6.1	......	......	......	Niagaran. Sample received from H. C. Peterson, Park Ridge, Ill.
	3658	Thornton	Brownell Improvement Co. Chicago	2.63	164	7.1	1.98	......	5.6	......	8	......	Sample received from J. R. Goetzman, Vandalia, Ill.
Cook[c]	L 137	NW. cor. NW. ¼, sec. 21 T. 37 N., R. 12 E.	Along Calumet Feeder Canal	2.46	153	3.40	5.2	......	7.84	12.5	6	29	Niagaran
Dupage[a]	2678	Naperville	......	......	162	......	1.64	9.1	4.4	14.2	6	32	Dolomite
	5798	Elmhurst	......	......	165	......	.34	4.6	8.7	17.0	8	40	Niagaran
Dupage[b]	630	Elmhurst	Elmhurst-Chicago Stone Co.	2.68	167	......	1.9	4.9	8.2	......	......	......	Niagaran

	864	Elmhurst	Elmhurst-Chicago Stone Co.	2.69	168	......	2.4	5.2	7.7	......	6	...... Niagaran
	2100	Elmhurst	Elmhurst-Chicago Stone Co.	2.68	167	......	2.0	4.1	9.8	......	7	...... Niagaran
	3147	Elmhurst	Elmhurst-Chicago Stone Co.	2.69	168	......	2.10	5.4	7.4	......	......	...... Niagaran
Dupage[c]	L 166	NE. ¼, NW. ¼, sec. 30, T. 38 N., R. 10 E.	Mathilde Ory, Naperville Ill.	2.67	167	1.3	2.17	......	16.0	17.7	10	...... Niagaran
Edgar[a]	2389	Paris	......	......	168	......	1.02	5.4	7.4	13.7	7	34 McLeansboro
	2390	Paris	......	......	165	......	.88	5.3	7.5	15.2	6	35 McLeansboro
	2424	Cherrypoint	......	......	168	......	.69	6.6	6.0	15.7	4	30 McLeansboro
Effingham[a]	6370	Gillmore	......	......	168	......	.67	9.2	4.3	16.0	8	36 McLeansboro
Greene[b]	1910	Eldred	John Brogan, Eldred, Ill.	2.65	165	......	0.56	6.3	6.3	......	7	...... Burlington
Grundy[c]	L 176	Center S. line sec. 27, T. 34 N., R. 8 E.	Mr. Wainwright, Morris, Ill.	2.68	167	.59	0.79	......	5.0	......	......	53 Maquoketa
Hancock[a]	2401	Pontoosuc	......	......	159	......	4.89	8.0	5.0	8.7	4	40 Argillaceous limestone
	2402	Hamilton	......	......	159	......	3.71	6.5	6.2	17.2	5	61 ......
Hancock[b]	1835	Plymouth	John T. Wilson, Plymouth, Ill.	2.60	162	......	1.98	5.3	7.5	......	7	....
Hardin[c]	K X	SE. ¼, NE. ¼, sec. 35, T. 12 S., R. 7. E.	......	2.69	168	0.17	0.28	......	9.3	17.2	14	60 Ste. Genevieve
	......	Shetlerville	Golconda Portland Cement Co.	2.70	168	0.17	4.30	......	9.3	12.7	6.0	44 Ste. Genevieve
Henderson[a]	2400	Gladstone	......	......	162	......	1.36	9.1	4.4	9.7	5	42 Burlington
	3258	Biggsville	......	......	162	......	2.45	4.9	8.2	18.1	6	67 Burlington
Jackson[c]	L 80	NW. ¼, NW. ¼, sec. 34, T. 8 S., R. 4 W.	......	2.71	169	0.30	0.50	......	11.8	15.3	10	53 Chester
	L 90	Cen. sec. 24, T. 10 S., R. 3. W.	Mr. Fulker, Grand Tower, Illinois	2.63	164	0.91	1.49	......	10.0	15.9	8	50 St. Louis-Salem
	L 91	Cen. sec. 24, T. 10 S., R. 3 W.	Mr. Fulker, Grand Tower, Illinois	2.69	168	0.35	0.58	......	9.5	15.4	7	55 St. Louis-Salem
	L 92	Cen. sec. 24, T. 10 S., R. 3. W.	Mr. Fulker, Grand Tower, Illinois	2.68	167	0.24	0.40	......	11.8	15.6	10	56 St. Louis-Salem
Jersey[a]	9228	Grafton	......	......	159	......	3.68	6.1	6.6	12.5	5	26 Niagaran
	9229	Grafton	......	......	156	......	2.07	7.7	5.2	12.7	4	25 Niagaran
	9230	Grafton	......	......	162	......	1.83	7.1	5.6	16.5	4	14 Niagaran
Jersey[b]	566	Grafton	Grafton Quarry Co.	2.48	155	......	10.1	7.7	5.2	......	......	...... Niagaran

TABLE 5.—*Results of physical tests on Illinois limestones and dolomites*—Continued

County	Reference No.	Location	Company	Specific gravity	Wt. per cu. ft.	Absorption: Per cent	Absorption: Lbs. per cu. ft	Per cent of wear	Coefficients: French	Coefficients: Hardness	Coefficients: Toughness	Cementing value	Remarks
	571	Elsah	Western Whiting & Mfg., Co.	2.66	166		1.78	5.9	6.8				Burlington
	621	Grafton	Grafton Quarry Co.	2.51	157		4.6	6.1	6.6		8		Niagaran
	1021	Elsah	Western Whiting & Mfg., Co.	2.67	167		0.52	6.4	6.3		6		Burlington
	1200	Grafton	Grafton Quarry Co.	2.49	155		5.38	6.4	6.2		6.0		Niagaran
Jo Daviess[a]	452				168		1.80	13.1	3.0				
Jo Daviess[b]	1416	Scales Mound	W. B. Alexander, Chicago Illinois	2.71	169		1.37	6.3	6.4		6.0		
	1532	Warren	W. Ehrler, Galena, Ill.	2.75	170		1.15	5.6	7.1		7.0		
	1558	Galena	Galena Limestone Co.	2.70	168		1.45	7.1	5.6				Galena
Jo Daviess[c]	L 323	SE. ¼, NW. ¼, sec. 21, T. 28 N. R. 1 E.		2.65	165	0.4	0.65		9.5		7		Galena
	L 325	SW. ¼, sec. 17, T. 28 N., R. 1 W		2.61	163	1.57	2.56		6.6	13.0	5	42	Galena
	L 326	SW. ¼, sec. 36, T. 28 N., R. 1 E.		2.62	163	1.49	2.43		7.7	14.4	9	41	Galena
Johnson[c]	K 29	S. cen. sec. 16, T. 12 S., R 3 E.		2.68	167	.33	.57		10.0	16.6	12	73	Kinkaid
	K 32	SW. ¼, sec. 33, T. 12 S., R. 2 E.		2.70	168	.23	.40		12.1	16.1	10	216	Menard
	6598	Vienna (near)			165		.73	3.8	10.5	17.8	20	73	Vienna (?)
	7007	Whitehill	Charles Stone Co.		168		.34	6.8	5.9	13.9	4	51	Ste. Genevieve
Johnson[b]	590	Whitehill	Charles Stone Co.	2.69	168		.71	4.4	9.1		8		Ste. Genevieve
Johnson[a]	7509	Reevesville			168		.27	5.1	7.8	15.7	6	79	Menard (?)
	7510	Reevesville			168		.34	4.1	9.7	16.3	6	55	Menard (?)
	7617	Cypress			168		.59	3.9	10.2	15.2	7	21	Renault (?)
Kane[a]	2638	Batavia			172		1.06	4.9	8.2	13.1	7	49	
	5096	Batavia			165		3.14	6.3	6.4	12.1	9	26	Niagaran
	5097	Batavia			165		3.44	5.3	7.5	13.9	8	32	Niagaran
	5098	Batavia			168		2.44	4.3	9.4	15.4	9	29	Niagaran
	7558	Elgin			172		1.61	4.3	9.3	16.9	16	39	Niagaran
Kane[c]	L 157	SE. ¼, NE. ¼, sec. 27, T. 39 N., R. 8, E.	John Hendrickson, Batavia	2.52	157	4.2	6.6		8.9		6	84	Niagaran
	L 156	SE. ¼, NE. ¼, sec. 27, T. 39, N., R 8 E.	John Hendrickson, Batavia	2.58	161	2.49	4.01		8.7	15.2	7	31	Niagaran

	I. 161	NW. ¼, NW. ¼, sec. 27, T 39 N., R. 8, E.	A. L. Carlisle, Geneva	2.58	161	2.9	4.67	.....	8.5	12.2	7	37	Niagaran
Kankakee[a]	4764	Kankakee	.....	.....	168	.....	2.48	4.4	9.2	12.9	7	.....	Niagaran
	5550	Kankakee	.....	.....	165	.....	2.30	6.9	5.8	13.3	5	20	Niagaran
	6088	Kankakee	.....	.....	172	.....	1.56	4.5	8.9	15.2	9	12	Niagaran
	6165	Kankakee	.....	.....	162	.....	3.71	5.7	7.0	13.0	4	14	Niagaran
	6443	Kankakee	.....	.....	168	.....	2.97	9.0	4.4	11.7	5	33	Niagaran
	6865	Kankakee	.....	.....	162	.....	1.73	6.0	6.7	13.8	4	57	Niagaran
	7023	Kankakee	.....	.....	159	.....	2.24	7.2	5.6	9.0	4	28	Niagaran
	7025	Lehigh (near)	.....	.....	165	.....	3.28	5.3	7.5	9.2	6	22	Niagaran
	7026	Tucker (near)	.....	.....	170	.....	1.04	7.7	5.2	14.2	8	9	Niagaran
	7027	Manteno (near)	.....	.....	172	.....	.84	7.2	5.6	14.0	4	17	Niagaran
	7028	Kankakee	.....	.....	162	.....	1.29	6.5	6.2	9.5	4	40	Niagaran
	7029	Bonfield	.....	.....	168	.....	2.76	5.2	7.7	13.2	7	17	Niagaran
	7071	Kankakee	.....	.....	165	.....	2.82	6.0	6.7	11.3	4	32	Niagaran
	7072	Kankakee	.....	.....	165	.....	3.31	6.8	5.9	10.7	5	25	Niagaran
	7289	Kankakee	.....	.....	168	.....	1.89	4.8	8.3	14.3	10	44	Niagaran
	7299	Kankakee	.....	.....	165	.....	3.23	4.9	8.1	13.9	7	38	Niagaran
	7300	Kankakee	.....	.....	168	.....	7.00	4.5	8.8	14.5	6	58	Niagaran
	7301	Kankakee	.....	.....	162	.....	2.28	5.5	7.3	14.3	8	42	Niagaran
	7302	Kankakee	.....	.....	162	.....	1.86	7.0	5.7	14.5	7	28	Niagaran
	7525	Lehigh	.....	.....	162	.....	4.98	5.2	7.7	10.8	5	77	Niagaran
	7526	Lehigh	.....	.....	165	.....	3.05	4.2	9.5	13.8	6	43	Niagaran
	7736	Kankakee	.....	.....	168	.....	1.39	4.8	8.4	15.3	9	45	Niagaran
	7871	Lehigh	.....	.....	168	.....	2.25	3.7	10.7	14.7	7	36	Niagaran
Kankakee[b]	579	Kankakee	Lehigh Stone Co.	2.68	167	.....	3.7	2.5	16.0	.....	.....	.....	Niagaran
	588	Kankakee	McLaughlin Mateer Co.	2.63	164	.....	2.2	6.0	6.7	.....	.....	.....	Niagaran
	670	Kankakee	McLaughlin, Cook & Co.	2.63	164	.....	2.0	6.8	5.9	.....	.....	.....	Niagaran
	789	Kankakee	Lehigh Stone Co.	2.66	166	.....	2.4	4.0	10.0	.....	.....	.....	Niagaran
	1573	Kankakee	Lehigh Stone Co.	2.63	164	.....	2.87	3.7	10.8	.....	.....	.....	Niagaran
	1708	Kankakee	Lehigh Stone Co.	2 65	165	.....	2.33	4.7	8.5	.....	.....	.....	Niagaran
	1966	Ledge near Kankakee River, two miles below Warner Bridge	F. M. Enos, County Supt of Highways, Kankakee.	2.69	167	.....	0.45	5.0	8.0	.....	6	.....	.....
	2021	Ledge one mile from Warner Bridge	F. M. Enos, County Supt. of Highways, Kankakee.	2.69	167	.....	0.57	5.6	7.1	.....	6	.....	Rock in thin strata of ½ inch to 1½ inches in thickness.

TABLE 5.—*Results of physical tests on Illinois limestones and dolomites*—Continued

County	Reference No.	Location	Company	Specific gravity	Wt. per cu. ft.	Absorption: Per cent	Absorption: Lbs. per cu. ft.	Per cent of wear	Coefficients: French	Coefficients: Hardness	Coefficients: Toughness	Cementing value	Remarks
	2191	West Side Quarry, Kankakee...	West Side Quarry, Kankakee........	2.54	158	......	2.6	9.5	4.2	......	6	......	Niagaran
	2192	West Side Quarry, Kankakee...	West Side Quarry, Kankakee........	2.64	165	......	2.9	6.5	6.2	......	8	......	Bottom rock—Niagaran
	3095	Kankakee........	F. C. Feutz, Danville.....	......	......	......	......	4.5	8.9	......	......	......	62 pieces required for abrasion test instead of standard 50 pieces.
Kankakee...	2491	Kankakee........	Lehigh Stone Co........	2.69	168	......	0.79	5.2	7.7	......	......	......	Niagaran—66 pieces required for abrasion test instead of standard 50 pieces
	3492	Kankakee........	Lehigh Stone Co........	2.64	164	1.47	4.6	8.7	......	......	......	......	Niagaran
	3493	Kankakee........	Lehigh Stone Co........	2.59	161	......	2.03	8.4	4.7	......	......	......	Niagaran
	3494	Kankakee........	Lehigh Stone Co........	2.60	162	......	2.52	4.6	8.7	......	......	......	86 pieces required for abrasion test instead of standard 50 pieces
Kankakee[c]...	L 103	SW. ¼, SW. ¼, sec. 32, T. 32 N., R. 11 E........	Kankakee-Will Counties...	2.73	170	4.0	6.8	......	7.4	10.7	7	......	Richmond
	L 107	SE. ¼, NE. ¼, sec. 20, T. 32 N., R. 12 E........	Luther Smith, Manteno...	2.61	163	2.07	3.37	......	5.8	15.8	6	63	Niagaran
	....	NW. ¼, sec. 7, T. 30 N., R. 14 W........	Lehigh Stone Co.[1].......	......	......	......	......	......	9.62	16.2	9.5	......	Niagaran
Kendall[c]....	L 164	NE. ¼, SW. ¼, sec. 17, T. 37 N., R. 8 E........	George White and Fred Kohlhammer, Oswego...	2.79	174	0.9	1.57	......	9.3	14.2	9	25	Richmond

	L 165	NE. ¼, SW. ¼, sec. 8, T. 37 N., R. 8 E.	Mr. G. Watt, Oswego	2.73	170	0.69	1.17	......	14.8	16.6	12	29	Niagaran
	L 170	NE. ¼, SW. ¼, sec. 21, T. 35 N., R. 7 E.	Lisbon Township	2.67	167	0.99	1.65	......	7.6	16.3	6	......	....
	L 173	SW. ¼, sec. 15, T. 35 N., R. 8 E.	....	2.66	166	0.40	0.66	......	7.1	14.5	8	38	Maquoketa
LaSalle[b]	1559	Ottawa	Ottawa Stone & Sand Co., Ottawa	2.73	170	......	0.58	4.4	9.1	......	7.0	......	....
LaSalle[c]	L 177	SW. ¼, SW. ¼, sec. 7, T. 33 N., R. 2 E.	Utica Cement Co.	......	......	......	......	......	......	8.7	6	......	Shakopee..
	L 179	SW. ¼, SW. ¼, sec. 7, T. 33 N., R. 2 E.	Utica Cement Co.	2.40	150	2.1	3.2	......	1.5	17.7	7	65	Shakopee
	L 180	NW. ¼, sec. 6, T. 32 N., R. 2 E.	Bailey Fall Dairy Farm	2.69	168	1.57	2.64	......	9.1	......	......	45	LaSalle
	L 181	NW. ¼, sec. 6, T. 32 N., R. 2 E.	Bailey Fall Dairy Farm	2.63	168	0.80	1.36	......	10.0	......	......	......	LaSalle
	L 183	NE. ¼, SW. ¼, sec. 35, T. 35 N., R. 1 E.	E. L. Larkin, Troy Grove.	2.58	161	1.74	2.8	......	12.5	16.0	11	32	Galena-Trenton
Lee[a]	5954	Dixon	....	......	172	......	1.38	4.7	8.4	16.7	4	86	Dolomite
	9509	Dixon	....	......	168	......	1.96	8.5	4.7	......	......	69	Argillaceous limestone
Lee[b]	1739	Dixon	C. R. Leake, Dixon, Ill.	2.70	168	......	2.00	7.7	5.2	......	6.0	......	....
	3047	City Quarry, Dixon	W. H. Rink, Dixon, Ill.	2.69	167	......	2.86	7.0	5.7	......	12	......	....
Lee[c]	L 188	SE. ¼, SW. ¼, sec. 21, T. 22 N., R. 9 E.	State Hospital of the Insane, Dixon	2.65	165	1.17	1.93	......	9.5	17.2	5	32	Platteville
	L 194	NE. ¼, SE. ¼, sec. 26, T. 22 N., R. 9 E.	G. S. Jeanguenat, Dixon	2.65	165	1.0	1.65	......	12.1	......	......	......	Platteville
	L 197	SW. ¼, NE. ¼, sec. 23, T. 22 N., R. 10 E.	O. C. Edgington, Franklin Grove, Ill.	2.59	162	1.6	2.59	......	7.6	......	......	26	Platteville
	L 200	SE. cor. sec. 6, T. 20 N., R. 11 E.	L. L. Ullrich, Lee Center, Ill.	2.64	165	1.4	2.31	......	10.5	14.3	8	32	Platteville
	L 203	SW. ¼, NW. ¼, sec. 8, T. 21 N., R. 9 E.	W. M. Girton, Dixon	2.67	167	1.7	2.8	......	7.0	11.6	7	31	Galena
	L 211	Cen. SW. ¼, sec. 9, T. 20 N., R. 11 E.	Green River Drain Canal.	2.70	168	0.5	0.8	......	8.9	......	8	31	Platteville
	L 212	NW. ¼, NW. ¼, sec. 24, T. 20 N., R. 10 E.	Green River Drain. Canal.	2.61	163	2.3	3.7	......	3.1	9.0	6	68	Galena

TABLE 5.—*Results of physical tests on Illinois limestones and dolomites*—Continued

County	Reference No.	Location	Company	Specific gravity	Wt. per cu. ft.	Absorption: Per cent	Absorption: Lbs. per cu. ft.	Per cent of wear	Coefficients: French	Coefficients: Hardness	Coefficients: Toughness	Cementing value	Remarks
	L 216	NE. ¼, NW. ¼, sec. 20, T. 22 N., R. 11 E.	G. H. Van Ness, Ashton	2.69	168	0.3	0.5	......	11.8	......	9.0	45	Platteville
	L 223A	Cen. sec. 10, T. 21 N., R. 8 E.	Mr. Miller, Dixon	2.75	172	1.28	2.2	......	16.0	17.0	7.0	26	Galena
	L 223B	Cen. sec. 10, T. 21 N., R. 8 E.	Mr. Miller, Dixon	2.72	170	2.4	4.1	......	5.6	11.7	10	28	Galena
	L 229	Cen. sec. 34, T. 22 N., R. 9 E.	Mr. Truesdale, Dixon	2.79	174	1.3	2.3	......	11.4	16.0	7	48	Platteville
	L 234A	SW. ¼, NE. ¼, sec. 33, T. 22 N., R. 9 E.	Sandusky Cement Co., Dixon, Ill.	2.64	165	0.8	1.3	......	4.9	15.3	8	38	Platteville
	L 234B	SW. ¼, NE. ¼, sec. 33, T. 22 N., R. 9 E.	Sandusky Cement Co., Dixon, Ill.	2.60	162	1.2	1.94	......	9.3	15.2	9	......	Platteville
	L 241	NW. ¼, NE. ¼, sec. 27, T. 22 N., R. 11 E.	Ashton Township	......	......	......	......	......	......	15.2	6	......	Galena
Logan[b]	3372	Rankin Stone, Logan County	Submitted by T. S. Davy, County Supt. of Highways, Lincoln, Ill.	2.63	164	......	3.45	......	......	......	......	......	McLeansboro—Sample too small for complete tests
	3373	Rankin Stone, Logan County	Submitted by T. S. Davy, County Supt. of Highways, Lincoln, Ill.	2.60	162	......	4.1	......	......	......	5	......	McLeansboro—Sample too small for complete tests
	3374	Rankin Stone, Logan County	Submitted by T. S. Davy, County Supt. of Highways, Lincoln, Ill.	2.66	166	......	1.07	6.2	6.4	......	6	......	McLeansboro
	3671	Logan County	Submitted by T. S. Davy, County Supt. of Highways, Lincoln, Ill.	2.67	166	......	1.5	4.8	8.3	......	7	......	McLeansboro
Madison[a]	4421	Alton	......	......	168	......	.82	5.7	7.1	14.0	7	25	St. Louis (?)

Madison[b]	8145	......	......	......	168	......	.77	3.4	11.8	16.0	6	38 St. Louis (?)
	580	Alton	Reliance Quarry & Construction Co.	2.65	165	......	2.6	3.8	10.5	......	......	...... St. Louis
	583	Alton	Lockyer Quarry Co.	2.69	168	......	0.72	4.9	8.0	......	......	...... St. Louis (?)
	634	Alton	Mississippi Sand Co.	2.71	169	......	0.31	3.3	12.1	......	......	...... St. Louis
	908	Alton	Reliance Quarry & Construction Co.	2.68	167	......	0.65	5.2	7.7	......	6	...... St. Louis
	945	Alton	Reliance Quarry & Construction Co.	2.67	167	......	1.1	3.7	10.8	......	......	...... St. Louis
	1030	Alton	Harry Gissal Quarry Co.	2.68	167	......	0.56	4.3	9.3	......	7	...... St. Louis
	3117	Saline Quarry, Grantfork, Ill.	Stocker Gravel & Construction Co.	2.70	168	......	1.10	3.8	10.5	......	12	...... Pennsylvanian Sample from W. E. Howden, Edwardsville, Ill.
Menard[b]	1854	Near Athens	Submitted by R. Y. Kincaid, Athens	2.62	163	......	1.62	5.7	7.0	......	6	......
Monroe[a]	8146	......	......	......	162	......	3.42	2.8	14.0	11.8	6	49 ......
Monroe[b]	1013	Columbia	Columbia Quarry Co.	2.60	162	......	2.1	5.0	8.0	......	7	......
	1789	Columbia	Columbia Quarry Co., St. Louis, Mo.	2.64	164	......	1.47	3.6	11.1	......	8.0	......
Monroe[c]	L 66	Cen. S. line, sec. 17, T. 1 S., R. 10 W.	......	2.70	168	.23	.38	......	12.1	13.3	8	211 Ste. Genevieve
	L 67	SW. ¼, NW. ¼, sec. 21, T. 3 S., R. 8 W.	......	2.67	167	.44	.73	......	12.9	14.3	9	56 Okaw
	L 68	Cen. E. ½, sec. 3, T. 3 S., R. 11 W.	Columbia Quarry Co.	2.60	162	.98	1.60	......	5.6	......	4	35 Kimmswick
	L 69	Middle N. line NE. ¼, sec. 18, T. 2. S., R. 10 W.	Mr. Wessel, New Hanover, Illinois	2.67	167	.51	.83	......	10.5	14.3	8	132 St. Louis
	L 70	NW. ¼, SE. ¼, sec. 15, T. 3 S., R. 11 W.	......	2.56	160	1.52	2.31	......	7.0	14.6	8	95 Salem
	L 71	SW. ¼. NW. ¼, sec. 5, T. 4 S., R. 10 W.	Ed. Maeys, Maeystown, Ill.	2.70	168	0.53	0.89	......	10.5	15.6	13	40 St. Louis
Montgomery[a]	3118	Hillsboro	......	......	172	......	2.60	6.0	6.7	14.4	6	44 Shoal Creek
				2.60	162	2.2	3.6	3.8	10.5	15.3	7	44 Top Bed *
Montgomery	L 425	Litchfield	Kiggins Crushed Stone Co.	2.67	167	0.5	0.8	3.9	10.3	17.0	8	83 Middle bed *
				2.73	170	1.1	1.9	2.9	13.8	17.3	14	60 Bottom bed *
Moultrie[b]	1049	Sullivan	J. C. Shields, Sullivan	2.79	174	......	0.9	9.3	4.3	......	....	...... Pennsylvanian

* Shoal Creek limestone

TABLE 5.—*Results of physical tests on Illinois limestones and dolomites*—Continued

County	Reference No.	Location	Company	Specific gravity	Wt. per cu. ft.	Absorption: Per cent	Absorption: Lbs. per cu. ft.	Per cent of wear	Coefficients: French	Coefficients: Hardness	Coefficients: Toughness	Cementing value	Remarks
Ogle[a]	7213	Brookville (near)			172		.82	6.4	6.3	10.6	3	64	Argillaceous dolomite
	7421	Brookville (near)			165		2.64	5.4	7.4	15.0	7	105	Argillaceous dolomite
	7422	Brookville (near)			165		3.45	6.1	6.6	14.2	5	67	Argillaceous dolomite
	7423	Brookville (near)			165		2.70	5.2	7.6	13.6	7	74	Argillaceous dolomite
Ogle[b]	755	Oregon		2.74	171		1.6	5.8	6.9				
	1602	Oregon	Submitted by F. O. Lowden Oregon	2.72	169		1.88	5.6	7.1		8.0		
Ogle[c]	L 190	NW. ¼, NW. ¼, sec .8, T. 22 N. R. 9 E.	Herman Hughes, Dixon, Ill.	2.68	167	1.0	1.67		10.3	15.8	8	35	Platteville
	L 193	NW. ¼, SW. ¼, sec 12, T. 22 N. R. 9 E.	W. Andrews, Grand Detour, Ill.	2.72	170	.89	1.52		6.8	15.5	11		Platteville
				2.45	153	3.4	2.51		9.1	14.2	5	39	Galena
	L 202A	Cen. W. ½, sec. 2, T. 23 N., R. 10 E.	E. A. Young, Oregon Ill.	2.71	169	2.9	4.9		6.6	15.0		31	Platteville
	L 202B	Cen. W. ½ sec. 2, T. 23 N., R. 10 E.	E. A. Young, Oregon, Ill.	2.78	173	0.4	0.7		4.8	13.0			Platteville
	L 237	Cen. S. ½, sec. 34, T. 24 N., R. 10 E.	W. Heckman	2.56	160	2.77	4.43		8.3	16.0	10	30	Platteville
	L 239	Middle N. line sec 33., T. 25 N., R. 10 E.	Mr. Hagelman, Egan, Ill.	2.70	168	1.9	3.2		4.2				Platteville
Ogle	L 240	Cen. S. ½, sec. 25, T. 25 N., R. 9 E.	Mr. Schilling, Leaf River, Ill.	2.64	165	1.5	2.5		4.5	17.3	7	53	Platteville
	L 251	NW. ¼, NW. ¼, sec. 17, T. 23 N., R. 8 E.	Buffalo Township, Polo, Ill.	2.75	172	1.8	3.1		5.4	13.3	6	34	Galena
	L 252	SW. ¼, NE. ¼, sec. 18, T. 23 N. R. 8 E.		2.66	166	0.39	0.65		4.3	15.7	7	16	Platteville

	L 266	SE. ¼, SW. ¼, sec. 21, T. 25 N., R. 9 E.	......	2.73	170	1.37	2.33	......	8.2	15.5	8	50	Galena
	L 267	NW. cor. sec. 4, T. 23 N., R. 10 E.	City of Oregon	2.64	165	1.8	2.97	......	6.8	7.5	6	......	Platteville
	L 271	Cen. S. ½, sec. 29, T. 25 N., R. 11 E.	Mr. C. N. Rood, Byron, Ill.	2.74	171	3.6	6.2	......	10.5	16.0	7	29	Platteville
Peoria[a]	2393	Princeville	......	......	165	......	1.73	4.0	10.1	16.0	5	23	Lonsdale (?)
	2304	Maxwell	......	......	165	......	1.48	5.0	8.0	13.5	8	42	Lonsdale (?)
	2395	Maxwell	......	......	162	......	1.71	5.3	7.6	10.7	6	56	Lonsdale (?)
Pike[b]	2025	Griggsville	Submitted by Cameron, Joyce & Co., Keokuk, Ia.	2.63	164	......	1.0	7.1	5.7	......	8	......	Rock of uniform texture, Burlington
Pulaski[a]	450	Ullin	......	......	156	......	3.79	5.6	7.2	......	......	......	Siliceous limestone
Randolph[a]	1292	Chester	......	......	168	......	.79	3.8	10.4	14.0	6	87	......
	1293	Chester	......	......	159	......	2.93	4.5	8.8	2.2	4	40	Fossiliferous limestone
Randolph[c]	K 8	Middle S. Line SE. ¼, sec. 14, T. 7 S., R. 7 W.	Penitentiary at Menard	2.53	158	1.99	3.14	......	6.25	15.2	4	86	Okaw
	K 9	¼ mi. NW. of Prairie du Rocher	......	2.69	168	0.20	0.33	......	10.0	15.4	8	51	St. Louis
	K 12A	NW. ¼, sec. 30, T. 7 S., R. 6 E.	......	2.72	170	0.30	0.51	......	12.5	14.1	9	84	St. Louis
	K 13A	Cen. NW. ¼, sec. 30, T. 7 S., R 6 W.	......	2.61	163	1.01	1.78	......	8.9	14.1	7	115	Okaw
	K 13B	Cen. NW. ¼, sec. 30, T. 7 S., R. 6 W.	......	2.70	168	.22	0.37	......	11.4	15.3	8	77	Menard
	K 13C	Cen. NW. ¼, sec. 30, T. 7 S., R. 6 W.	......	2.69	168	.20	0.35	......	13.8	15.6	10	54	Menard
	K 13D	Cen. NW. ¼, sec. 30, T. 7 S., R. 6 W.	......	2.66	166	.40	0.66	......	14.3	16.6	11	156	Menard
	K 17B	Near Cen. sec. 33, T. 7 S., R. 6 W.	......	2.63	164	.71	1.17	......	10.0	15.1	8	77	Menard
	K 22	Cen. SE. ¼, sec. 24, T. 38 N., R. 8 W.	......	2.66	166	.54	0.91	......	9.5	11.8	7	189	Okaw
	K 23	NW. ¼, sec. 12, T. 6 S., R. 8 W.	......	2.67	167	.49	0.80	......	10.3	15.4	9	318	Okaw
	K 24A	SW. ¼, sec. 4, T. 6 S., R. 8 W.	......	2.67	167	.37	.61	......	11.4	15.5	8	192	Okaw
	K 26	At nose of hill about ¼ mi. NE. of Prairie du Rocher	......	2.67	167	.38	.65	......	12.5	14.6	8	115	St. Louis
Rock Island[a]	2398	Moline	......	......	165	......	.99	5.0	8.0	14.0	6	34	Hamilton
	2399	Port Byron	......	......	175	......	.83	5.8	6.9	14.3	8	30	Niagaran

TABLE 5.—*Results of physical tests on Illinois limestones and dolomites*—Continued

County	Reference No.	Location	Company	Specific gravity	Wt. per cu. ft.	Absorption: Per cent	Absorption: Lbs. per cu. ft	Per cent of wear	Coefficients: French	Coefficients: Hardness	Coefficients: Toughness	Cementing value	Remarks
Rock Island[b]	3659	Near Mississippi River in Rock Island	Submitted by C. E. Sikes, Hampton, Ill.	2.58	161	.....	1.4	9.7	4.1	.....	8	.....	Yellow top rock
St. Clair[a]	770	Smithton	.....	.....	168	.....	.30	4.4	9.2	.....	.....	.....	.....
	786	Smithton	.....	.....	168	.....	.17	5.9	.....	.....	.....	88	.....
	7214	Columbia	.....	.....	162	.....	2.56	3.4	11.6	11.9	5	81	.....
	7622	Stolle	.....	.....	168	.....	.28	4.3	9.2	14.7	7	48	St. Louis
	7734	East St. Louis	.....	.....	168	.....	.47	4.3	9.4	14.3	8	23	.....
	8148	.....	.....	.....	168	.....	.72	3.0	13.2	16.7	6	69	.....
St. Clair[b]	584	East St. Louis	East St. Louis Stone Co.	2.70	168	.....	0.43	5.0	8.0	.....	.....	.....	St. Louis
	592	East St. Louis	Casper-Stolle Quarry & Construction Co.	2.69	168	.....	0.50	4.0	10.0	.....	.....	.....	St. Louis
	676	East St. Louis	Casper-Stolle Quarry & Construction Co.	2.70	168	.....	0.30	5.0	8.0	.....	9	.....	St. Louis
	1225	East St. Louis	Hill-Thomas Lime & Cement Co., East St. Louis	2.68	167	.....	0.50	5.6	7.1	.....	7.0	.....	.....
	1280	East St. Louis	Hill-Thomas Lime & Cement Co., East St. Louis	.....	.....	.....	.....	4.2	9.5	.....	.....	.....	.....
Scott[a]	7652	Winchester	.....	.....	172	.....	.65	5.6	7.1	14.5	3	20	.....
Stephenson[b]	827	Freeport	Sanford & Zartman Lumber Co.	2.64	165	.....	2.7	15.9	2.5	.....	13	.....	Galena
	2143	Freeport	Sanford & Zartman Lumber Co.	2.64	165	.....	2.5	12.6	3.2	.....	.....	.....	Galena
Stephenson[c]	L 302	Cen. SE. ¼, sec. 22, T. 29 N., R. 6 E.	Winslow Village Quarry	2.74	171	1.9	3.3	.....	8.2	10.3	8	40	Platteville
	L 304	Cen. sec. 36, T. 29 N., R. 7 E.	M. Barker ,Orangeville Ill.,	.....	.....	.....	.....	.....	.....	.....	.....	7	Platteville
	L 306	SE. ¼, SE. ¼, sec. 13, T. 28 N., R. 5 E.	Mr. Lutz, Waddams Grove, Ill.	2.45	153	2.99	4.57	.....	5.9	14.3	5	33	Niagaran
	L 310	SE. cor. sec. 8, T. 26 N., R. 6 E.	Loran Township	2.75	172	2.5	4.3	.....	7.3	13.2	7	55	Maquoketa shale
Union[a]	3225	Anna	.....	.....	168	.....	.61	4.2	9.5	.....	.....	15	Ste. Genevieve
	5549	Anna	.....	.....	168	.....	.42	3.3	12.0	14.3	9	16	Ste. Genevieve

	7623	Anna	.....	.....	165	.....	1.08	5.0	8.1	15.3	5	58	Ste. Genevieve
Union[b]	1110	Anna	C. F. Massey Co., Anna Ill.,	2.69	167	.....	0.82	3.9	10.2	.....	18.0	.....	Ste. Genevieve
	K 71	Tunnel Cut, sec. 2, T. 12 S., R. 2 W.	.....	2.61	163	0.8	1.3	.....	8.2	14.7	8	36	Warsaw-Spergen
Vermilion[a]	2388	Fairmount	.....	.....	165	.....	1.20	5.1	7.9	14.0	8	40	.....
Will[a]	1298	Joliet	.....	.....	168	.....	2.58	4.3	9.4	12.9	6	35	Niagaran
	2774	Joliet	.....	.....	165	.....	1.33	5.8	6.9	15.4	5	27	Niagaran
	2775	Joliet	.....	.....	165	.....	1.75	5.2	7.7	15.0	8	23	Niagaran
	2776	Joliet	.....	.....	172	.....	2.87	4.7	8.4	15.7	9	43	Niagaran
	2777	Joliet	.....	.....	168	.....	2.21	4.7	8.5	14.3	10	74	Niagaran
	8075	Joliet	.....	.....	165	.....	.76	10.3	3.9	13.8	6	100	Niagaran
Will[b]	570	Joliet	Western Stone Co.	2.75	171	.....	1.01	3.2	12.5	.....	.....	.....	.....
	572	Joliet	National Stone Co.	2.76	172	.....	1.99	5.0	8.0	.....	.....	.....	Niagaran
	573	Joliet	National Stone Co.	2.70	168	.....	3.16	5.4	7.4	.....	.....	.....	Niagaran
	694	Joliet	National Stone Co.	2.69	168	.....	1.1	3.7	10.8	.....	7	.....	Niagaran
	740	Joliet	Ideal Stone Co.	2.72	170	.....	1.2	5.1	7.9	.....	13	.....	Niagaran
	905	Joliet	National Stone Co.	2.66	163	.....	0.80	4.0	10.0	.....	.....	.....	Niagaran
	974	Joliet	Joliet Artificial Stone Co.	2.76	172	.....	1.1	5.0	8.0	.....	19	.....	Niagaran
	1182	Joliet	State Penitentiary, Joliet.	2.71	169	.....	1.72	4.0	10.0	.....	10.0	.....	Niagaran
	1244	Joliet	National Stone Co.	2.72	172	.....	0.89	3.8	10.5	.....	.....	.....	Niagaran
	1890	Romeo	Joliet Crushed Stone Co., Joliet	2.59	161	.....	4.0	5.0	8.0	.....	7	.....	Niagaran
	2084	Joliet	National Stone Co.	2.70	168	.....	1.25	4.6	8.6	.....	12	.....	Niagaran
	3149	Joliet	National Stone Co.	2.76	172	.....	0.85	4.2	9.5	.....	.....	.....	Niagaran
Will[c]	L 111A	SE. ¼, SE. ¼, sec. 17, T 35 N., R. 10 E.	Markgraf Stone Co., Joliet	2.68	167	1.36	2.27	.....	8.7	15.8	7	37	Niagaran
	L 111B	SE. ¼, SE. ¼, sec. 17, T. 35 N., R. 10 E.	Markgraf Stone Co., Joliet	2.67	167	1.10	1.84	.....	9.1	18.1	6	38	Niagaran
	L 111C	SE. ¼, SE. ¼, sec. 17, T. 35 N., R. 10 E.	Markgraf Stone Co., Joliet.	2.64	165	2.96	4.89	.....	7.6	16.0	7	62	Niagaran
	L 112	SW. ¼, SE. ¼, sec. 20, T. 35 N., R. 10 E.	Lincoln Crushed Stone Co., Joliet	2.67	167	0.89	1.50	.....	9.3	15.5	8	26	Niagaran
	L 117A	Middle N. line, NE. ¼, sec. 31, T. 33 N.	Mr. Barr, Wilmington, Ill.	2.55	159	2.59	4.12	.....	10.1	.....	8	62	Edgewood
	L 117B	Cen. N. line, NE. ¼, sec. 31, T. 33 N., R. 10 E.	Mr. Barr, Wilmington, Ill.	2.68	167	1.02	1.70	.....	11.8	15.2	9	21	Edgewood
	L 119	NW. cor. NE. ¼, sec. 15, T. 35 N., R. 9 E.	P. Meyer, Joliet, Ill.	2.58	161	2.6	4.18	.....	11.4	16.2	9	55	Niagaran

TABLE 5.—*Results of physical tests on Illinois limestones and dolomites*—Concluded

County	Reference No.	Location	Company	Specific gravity	Wt. per cu. ft.	Absorption		Per cent of wear	Coefficients			Cementing value	Remarks
						Per cent	Lbs. per cu. ft.		French	Hardness	Toughness		
	L 122	SE. ¼, NE. ¼, sec. 14, T. 34 N., R. 10 E.	Mr. McFarland, Elma, Ill.	2.60	162	0.89	1.44	......	8.0	12.3	5	22	Cincinnatian
	L 123	SW. ¼, NW. ¼, sec. 13, T. 34 N., R. 10 E.	Messrs. Lichtenwalter and Kreimeier, Manhattan, Ill.	......	......	......	......	......	......	15.3	10	......	Niagaran
	L 124	SE. ¼, SW. ¼, sec. 10, T. 33 N., R. 11 E.		2.54	158	1.68	2.66	......	10.3	......	......	61	Niagaran
	L 125	SE. ¼, SE. ¼, sec. 20, T. 33 N., R. 11 E.		2.65	165	1.19	1.96	......	10.8	14.5	8	41	Niagaran
	L 126B	NE. ¼, SW. ¼, sec. 26, T. 32 N., R. 10 E.		2.78	173	0.3	5.19	......	8.9	16.0	8	73	Niagaran
	L 132	NW. ¼, SE. ¼, sec. 25, T. 37 N., R. 10 E.		2.67	167	0.89	1.49	......	8.34	18.5	6	54	Niagaran
	L 133	SW. ¼, NW. ¼, sec. 26, T. 36 N., R. 10 E.		2.53	158	3.14	4.96	......	5.64	9.84	6	86	Niagaran
	L 134	SE. ¼, SE. ¼, sec. 27, T. 36 N., R. 10 E.		2.65	165	1.48	2.44	......	8.9	14.0	7	63	Niagaran
Williamson[b]	590	Marion	The Charles Stone Co.	2.69	168	......	0.71	4.4	9.1	......	8	......	Ste. Genevieve
Winnebago[b]	1062	Rockford	The Carrico Stone Co.	2.70	168	......	2.3	5.8	6.9	......	7	......	Galena
Winnebago[c]	L 279	SW. ¼, SE. ¼, sec. 24, T. 29 N., R. 12 E.	Ed. Gleasman, Rockton, Ill.	2.52	157	2.8	4.48	......	6.7	......	6	43	Platteville

[1] Professor Hatt, Purdue University, Authority.
[a] Hubbard, Prevost and Jackson, F. H., The results of physical tests of road-building rock: U. S. Dept. of Agriculture, Bull. 370, pp. 23-26, 1916.
[b] Fifth report of the Illinois State Highway Department, pp. 252-256, 1917.
[c] See Quarry site descriptions.

TABLE 6.—*Average physical analyses of Illinois limestones and dolomites by formations*

Formation [1]	French coefficient	No. of samples	Hard-ness	No. of samples	Tough-ness	No. of samples	Cementing value	No. of samples
Pennsylvanian system								
McLeansboro limestone								
General average	8.0	18	14.6	12	6.8	18	37	12
Clark County	8.7	7	15.2	3	7.9	6	38	3
Edgar and Coles counties	7.7	5	14.7	5	6.0	5	35	5
LaSalle County (LaSalle limestone)	9.5	2	....	....	....	....	45	1
Peoria County (Lonsdale limestone)	8.6	3	13.4	3	6.3	3	40	3
Mississippian system								
Kinkaid limestone	11.0	2	16.3	2	11.0	2	145	2
Menard limestone	12.4	4	15.5	4	9.0	4	91	4
Okaw limestone	9.9	6	14.9	6	7.3	6	159	6
Ste. Genevieve limestone	10.7	2	15.3	2	11.0	2	135	2
St. Louis limestone	9.5	14	15.0	9	8.6	12	70	9
Salem limestone	7.0	1	14.6	1	8.0	1	95	1
Burlington limestone	6.35	14	12.8	5	6.2	14	52	5
Silurian system								
Niagaran dolomite								
Cook County	7.96	51	14.0	18	7.2	32	43	18
Joliet	8.75	29	15.1	17	8.0	23	53	17
Kankakee	7.87	50	13.5	33	6.9	38	39	32
Grafton	5.9	6	13.9	3	5.4	5	22	3
Edgewood limestone	10.9	2	15.2	1	8.5	2	42	2
Ordovician system								
Maquoketa shale	7.3	1	13.2	1	7.0	1	55	1
Maquoketa limestone	5.0	1	....	....	....	....	53	1
Richmond limestone	8.4	2	12.4	2	8.0	2	25	1
Kimmswick limestone	5.6	1	....	....	4.0	1	35	1
Galena dolomite	7.7	10	13.8	12	7.0	12	37	11
Platteville limestone	8.0	21	14.7	15	8.2	16	35	15
Shakopee dolomite	1.5	1	13.2	2	6.5	2	65	1

[1] Age succession of formations shown by placing oldest at bottom and youngest at top.

CHAPTER V.—QUARRY PRACTISE

By Frank Krey

Location of a Quarry Site

In choosing a shipping quarry site it is well to bear in mind that the mere proximity of a limestone deposit to a railroad does not in itself warrant erecting a quarry plant. After a preliminary examination to determine the character and quantity of rock available and the amount of overburden, it is advisable to make a comprehensive survey of the probable demand for crushed stone that can be supplied from the proposed quarry, present and potential transportation facilities, and the amount and kind of competition that will be met.

MARKET DEMANDS

Some idea regarding the probable demand and market for the product may be obtained from a study of the amount being used in the area to be served, and since most limestones suitable for use as road material are also suitable for ballast, aggregate in concrete, agricultural limestone, riprap, and rubble, all these uses should be taken into consideration. Furthermore, if the limestone deposit is of exceptional purity, the production of flux and lime may also be considered. Data obtained from a study of this kind are not only of great value in determining the feasibility of opening a quarry but also have bearing on the size of the proposed plant.

TRANSPORTATION FACILITIES AND RATES

Transportation is probably the most important single factor influencing the choice of a quarry site and should be given serious consideration. Some of the more important factors which must be considered are freight rates, size of the markets reached by railroad, connections with other railroads, character of traffic handled, general direction of movement of traffic, and car supply.

The freight rates are the biggest factor in determining the selling price of crushed stone and therefore the lower the freight rate the farther the stone may be shipped and sold at a given price. Furthermore freight rates vary with the different railroads so that a quarry located on one railroad may market its product in a town cheaper than another quarry which may be closer but located on a different railroad. Also when freight rates are unusually high many consumers who might use crushed limestone do not buy because of the high price.

It is obvious that a limestone deposit located along a railroad which does not reach the more populous towns of a region, or passes through only a few of them, is less ready for exploitation than one located along a railroad which reaches most of them. Furthermore, quarries located along the smaller railroads or electric lines may be required to pay switching charges to reach many of the larger towns in the vicinity. In many cases this additional charge is sufficient to prevent these quarries from competing with others which are farther away but have better railroad facilities.

To insure a wide market, good railroad connections are essential and a quarry which has access to two or more of the main railroads can reach a much wider territory than one having access to only one railroad.

The character of the traffic handled by the railroad is also important. If the railroad handles large quantities of coal it will be found no cars will be available for limestone in emergencies, as coal is given priority. On the other hand such roads usually have an abundance of cars suited for carrying limestone and under ordinary conditions could furnish an adequate supply.

On many railroads the movement of the loaded cars is mainly in one direction which necessitates the return of many empty cars. A quarry which can take advantage of this and use the cars without greatly diverting them will receive much better service and often lower rates.

The equipment of a railroad is also important, as a quarry of any size located on a road with an inadequate car supply is very apt to suffer from a car shortage whenever the demand for cars is above normal, with the result that production might be interfered with.

CHARACTER OF THE COMPETITION

Probable competition which the proposed quarry must meet should also be considered. Unless it is prepared to produce as cheaply as competing plants, its market will be limited to the immediate vicinity and unless this region includes populous areas the demand may be too small to warrant operating a quarry.

ENGINEERING ADVICE

If the conclusions drawn from the study of the foregoing problems are favorable the next step would be to engage a competent quarry engineer to make a detailed study of the site to determine whether or not crushed rock could be produced there at a cost which would warrant the erection of a plant at that locality. Each site is a problem in itself and the different factors which favor successful quarrying should be considered with reference to their applicability to the particular site under consideration.

Quarry Methods

The following pages which give a brief summary of the quarry methods employed in the State will serve to show how the different quarries accomplish similar results.

REMOVAL OF OVERBURDEN

The most satisfactory method of removing overburden depends on many factors and can be determined only when all the prevailing conditions at the chosen site are known. The most important factors in determining the method to be used are thickness and character of overburden, dumping area, irregularities in the surface of the underlying rock, height of face, and size of quarry.

The character and thickness of the overburden varies in different parts of the State. In the northern and central portions, it consists of soil, glacial drift, which consists of clay mixed with pebbles and boulders, or in some places, sand and gravel. In the western part of the State especially along the Mississippi the overburden consists mainly of fine wind-blown dust called loess, and in the southern part of the State the overburden consists of loess underlain by a residual material consisting of red clay and chert fragments.

The methods most commonly employed in handling overburden are steam shovel, hydraulic, drag-line, teams and scrapers, and hand shoveling into dump carts.

STEAM SHOVELING

Steam-shovel methods are used at most of the quarries in the State. A shovel having a bucket capacity from one-half to one yard is most commonly used for removing overburden of average thicknesses, and the material is loaded into small cars and hauled to the dump. Where the overburden is thick, larger shovels are used and where thin, it is usually "cast-over" one or more times before it is loaded. At one quarry where the amount of overburden to be removed is small the shovel loads directly into auto trucks. At another quarry where the rock quarried is only 16½ feet thick, a steam shovel with a long boom picks up the overburden and dumps it on the quarry floor far enough back from the face so as not to interfere with quarrying.

HYDRAULIC STRIPPING

In hydraulic stripping, water under pressure is shot from a nozzle, known as a monitor, against the bank of overburden and as the overburden caves it is washed into a collecting basin called a sump. From the sump, the material is pumped to settling pools or into some nearby stream. Where the overburden to be removed caps the hills or bluffs near some large stream it may be washed directly into the stream.

Hydraulic stripping is a cheap and efficient method of removing overburden, but can be used only where there is a plentiful supply of water and where a suitable dumping area is available. In Illinois, this method is used on a large scale only in the vicinity of Alton along Mississippi River where loess 50 feet thick is removed in this way.

DRAG-LINE SCRAPERS

Drag-line scrapers are used in only a few quarries within the State. The type most commonly used for this work is the boom derrick. For thicknesses of overburden of less than eight feet this method is considered by many to be more efficient than the steam shovel.

HORSE-DRAWN SCRAPERS

Teams and scrapers employed where the overburden is thin and the dumping area is close, are best adapted for use in quarries where the face to be quarried is high enough so that the stripping of a small area makes available a large quantity of stone.

Hand shoveling into dump wagons has been used at one of the penitentiaries in the State, but can hardly be considered a practical method for removing overburden on a large scale.

METHOD OF OBTAINING THE ROCK

HEIGHT OF FACE

The height of the face quarried varies greatly in different parts of the State. In the northern part where most of the quarries are pit quarries the average height of the face is between 35 and 50 feet, but in the western and southern portions of the State where most of the quarries are hillside or bluff quarries, the height of the face ranges from 50 to 120 feet, and the average height of face is between 70 and 80 feet.

At a few of the smaller quarries where production is small and irregular, and tripod drills are used, the height of the face worked is less than 20 feet.

DRILLING

At most quarries in the State, the blast holes are put down by churn drills and are drilled to the full depth of the face. However, tripod drills are commonly used at the quarries where the face is being worked in benches. Steam furnishes the power for drilling at most quarries, but compressed air and electricity are also used.

SIZE AND SPACING OF DRILL HOLES

The size and spacing of drill holes is dependent on the character of the rock, on the kind and quantity of explosive used and therefore varies at the different quarries. The particular spacing and size used at any one quarry is generally based on knowledge gained from experience. At one of the northern quarries where a 40-foot face is quarried, 5-inch drill holes are put down 10 to 12 feet back from the face and 10 feet apart. At a quarry in the southern part of the State where a 75-foot face is worked, 5⅝-inch holes are drilled 15 feet back from the edge and 15 feet apart. At still another quarry in the same part of the State where a 110-foot face is worked, 5⅝-inch drill holes are drilled 25 to 28 feet back from the face and 15 feet apart. At one quarry where tripod drills are used the holes are 18 feet deep, 10 to 12 feet back from the face, and about the same distance apart.

PRIMARY BLASTING

Forty per cent dynamite is the explosive most commonly used in blasting. Some quarries, however, prefer 60 per cent and a few employ a combination of 60 per cent in the bottom of the hole and 40 per cent in the upper portion. At several of the large quarries where the parting at the floor is not pronounced or where it is desirable to use a large amount of explosive in the bottom of the blast hole, "springing" is resorted to. This consists of exploding small amounts of dynamite at the bottom of the hole. The extent to which a hole is sprung depends on the additional amount of space desired.

In loading with dynamite the cartridges are usually slit open before inserting them in the hole so that when tamped they will completely fill the hole and leave no air space. The tamping in shallow holes is accomplished by using a long wooden pole and in the deeper holes a black of wood several feet long, fastened to the end of a rope is used. After the charge has been loaded and tamped, the rest of the hole is filled with sand or screenings. The amount of this material used varies with the depth and size of the hole, but in the deeper holes as much as 30 feet is filled with this material known as "stemming".

At one quarry in the State, the "stemming" is sealed with a quick setting cement composed of Plaster of Paris and screenings.

At most quarries only one row of holes is shot at a blast. At several quarries in the State where faces less than 40 feet high are worked, a blanket of rock about 15 feet wide is left along the foot of the face to be shot so that when the rock is blasted it is not thrown out over the quarry floor but remains practically in place. In blasting of this kind the charge in the holes does not come much above the top of the "blanket" or "buffer".

The amount of stone blasted down per pound of explosive varies at the different quarries. In several of the larger blasts made at an Illinois quarry working in a massive limestone, the amount of rock shot down for 1 pound of 40 per cent dynamite is about 5 tons. One quarry in the State reports 10 tons of rock per pound of dynamite, but such results are exceptional.

At practically all the quarries in the State the blasts are fired by electricity. Electric detonators and blasting caps with a high explosive which are ignited by an electric current passing through a thin wire are used to set off the charge. Where the holes are deep, several detonators are distributed through the charge. Instead of electric detonators some quarries having a high face use a detonating fuse which is about one-fourth of an inch in diameter and consists of a lead tube filled with tri-nitro toluene. If this fuse is used it is inserted in the hole at the time of loading and extends to the full depth. If several holes are shot at the same time the ends of the fuse from the different holes are connected to a main line of fuse and the main line is then fired with an electric detonator. As this fuse has a rate of detonation of about 15,000 feet per second and is in contact with the entire charge it makes the whole blast practically instantaneous.

Electricity for blasting may be derived from a blasting machine or live wire current. Where a number of holes are blasted at one time they are usually connected in series if blasting machine is used or in parallel where live wire current is used.

SECONDARY BLASTING

After the rock has been blasted down it is usually found that there are some masses which are too large to be handled by the equipment used at the quarry, and such masses must be broken further. The two methods most commonly used are "dobying" and "block-holing".

In "dobying", a stick of dynamite with fuse attached is placed on the rock to be broken, and is covered with mud and then fired. At some quarries where steam-shovel loading is used the shovel often loads rock masses larger than the primary crusher can take and when this is the case the large pieces of rock are broken on the car by mud-capping methods while the car stands at the foot of the incline. At other quarries such masses are broken by the same method at the crusher. In "block-holing" one or more holes are drilled in the mass to be broken and are then loaded with a stick or fraction of a stick of low-grade dynamite and exploded with a fuse.

HANDLING THE ROCK

LOADING

After the rock is blasted down, it is loaded and hauled to the crushers. At nearly all of the larger quarries in the State the rock is loaded by steam shovels. Hand loading is resorted to only at the smaller quarries.

The steam shovels generally employed in loading rock are of the larger types with buckets having a capacity of from one to four yards. Their ability to handle large-sized masses of rock reduces much of the secondary blasting and sledging, and their capacity for loading large quantities of rock eliminates a large number of laborers required in hand-loading. Hand-loading methods are used mainly where the production is too small to warrant steam-shovel operations, and in quarries where some of the rock is used for a particular purpose which makes sorting necessary.

HAULING

There are probably as many different systems of hauling the rock to crushers as there are quarries. At several quarries the rock is loaded into carts which are drawn to the crusher by horses; at some it is loaded into auto trucks; at others it is loaded into small cars which are pushed to the tipple by hand or hauled by mules. At most quarries, however, where steam-shovel loading is practiced, the rock is loaded into cars which are hauled to the tipple by small locomotives, and at one quarry in the State the cars are operated by electricity from a control tower located at one side of the quarry.

QUARRY CARS

The kind, shape, and size of quarry cars vary greatly at the different quarries. Where hand-loading is practiced, the cars are generally small, with a capacity of one and one-half to two tons. With steam-shovel loading, larger cars are used and in general, the larger the shovel the larger the cars. Cars with a capacity up to 12 yards are used, but the size used in the greater number of quarries is about four yards.

Most of the cars are side dump types, but locally end dump and hopper types are used. Cars which fit into a revolving cage and are dumped by turning the car completely over are also used.

TRACK LAYOUTS

Track layouts must of necessity conform to the plan of development of the quarry and therefore vary in the different quarries. In general, however, where hand-loading methods are employed, the tracks radiate from a main line and meet the working face at right angles. With steam-shovel loading, the loading track is parallel to the face, and where locomotives are used to haul cars, the track layout is sometimes a closed circuit so that with two locomotives a continuous supply of cars is maintained for the shovel. Where only one locomotive is used a siding is maintained at the bottom of the tipple but only a single track leads from tipple to shovel. With this arrangement, the locomotive brings the loaded cars to the tipple and takes back the empty cars from the siding.

CRUSHING THE ROCK

In producing crushed rock the limestone is first passed through a large primary crusher and then through smaller secondary crushers. The type of cusher most commonly employed is the gyratory, but at several plants the primary crushing is done by roll crushers and at one quarry a large jaw crusher is used.

The size of crushers used varies at the different plants. At most of the smaller plants, especially where hand-loading methods are practiced, the crushers are commonly smaller in size than a No. 7½. At large plants where steam-shovel methods are employed, crushers capable of taking a 5-foot or even a larger cube of stone are used. Where the primary crusher used is a No. 18 or larger, the secondary crushers range from No. 7½ to No. 5, but where the primary crusher is a No. 7½, the secondary crushers may be as small as No. 3. Where small amounts of crushed rock are produced for local purposes, small jaw crushers or pulverizers are employed.

At quarries producing agricultural limestone, hammer mills, ring mills, or ball mills are installed for grinding the rock.

SCREENING

The number, kind, and size of screens employed in separating the different sizes of crushed rock vary at the different quarries. Cylindrical rotary screens from 2½ to 7 feet in diameter and from 4 to 25 feet long, are used in screening out the coarser sizes and whip-tap and shaker screens are used for the smaller sizes, commonly less than 1⅛ inches. Many of the smaller quarries have only the cylindrical rotary screens.

The arrangement of the screens differs at the various quarries, and depends entirely on the design of the plant. Where the primary crusher of a plant is of large size, the broken rock is screened before it is sent to the secondary crushers to remove stone already crushed to size. Such screens are often designated as "scalping screens". In general, however, the screens are located above the storage bins so that as the different sizes are screened out they may be chuted into the bins below.

SUMMARY

In the selection of a quarry site each locality is a problem in itself and only a few principles have general application.

It is essential that the quality and quantity of rock obtainable be suitable for the purpose for which it is to be used; that there be an adequate market to warrant opening a quarry; that the transportation facilities be such that markets from the proposed quarry can be reached as cheaply as, or more cheaply than competing quarries, and that the cost of production of rock at the proposed site be no more than that of the competing quarries.

Furthermore, the manner of development, kind of equipment, and quarry methods to be employed are in large measure dependent on conditions which prevail at the site chosen, and can be determined only after thorough study, which is a task best accomplished by an experienced quarry engineer.

CHAPTER VI.—QUARRIES AND QUARRY SITES IN ILLINOIS.

By J. E. Lamar and Frank Krey

Introduction

In order to present the general features of the shipping quarries and the most promising sites for shipping quarries in summary form, Table 7, pages 74-83, and Table 8, pages 84-91, have been prepared. The term "shipping quarry site" has been used rather loosely to designate localities less than 1½ miles from a railroad having a sufficient quantity of stone to insure at least a moderate production over a comparatively long period. Quarries which have crushing machinery on the site but do not make a practice of shipping stone are considered as local quarries.

During the field work, each outcrop or quarry was given a specific reference number, but to avoid confusion only those referring to shipping quarries, sites for shipping quarries, local quarries and localities sampled are included in the text and have been located on the maps accompanying the county descriptions. In some cases outcrops of only local value were sampled because the site offered a good opportunity to obtain rock typical of certain phases or parts of the formation. Such tests are valuable in that they are applicable in a general way elsewhere where it may be desirable but impossible to take samples.

A detailed discussion of the limestone deposits of the State is given in Chapters VII to X.

TABLE 7.—*List of*

Reference No.	Location		Operator	Daily capacity of plant	Railroads
	County	Town			
				Tons	
K No. 110.	Adams.....	Quincy.....	Quincy White Lime Company	....	Wabash; Chicago, Burlington and Quincy
K No. 111.	Adams.....	Quincy.....	F. W. Menke.....	100	Wabash; Chicago, Burlington and Quincy
K No. 112..	Adams.....	Quincy.....	Black White Lime Company	100	Wabash; Chicago, Burlington and Quincy
K No. 113.	Adams.....	Marblehead.	Marblehead Lime Company	....	Wabash; Chicago, Burlington and Quincy
L No. 426..	Adams.....	Quincy.....	Quincy City Quarry	....	Chicago, Burlington and Quincy; Wabash; Quincy, Omaha and Kansas City
L No. 276[a].	Boone......	Belvidere...	Belvidere Crushed Stone Company	....	....
L No. 38...	Clark......	West York (1½ mile north)	Illinois Limestone Company	250	Big Four Railroad
L No. 136..	Cook.......	Thornton...	Brownell Improvement Company	....	Chicago and Eastern Illinois; Baltimore and Ohio
L No. 138..	Cook.......	Lemont.....	Consumers Company (formerly Illinois Stone Company)	....	Chicago and Joliet Electric; Chicago and Alton; Illinois and Michigan Canal
L No. 141..	Cook.......	Summit....	Consumers Company (formerly Argo Stone Company)	....	Santa Fe; truck
L No. 142..	Cook.......	McCook....	Consumers Company (formerly United States Crushed Stone Company)	....	Indiana Harbor Belt; Santa Fe; Chicago and Illinois Western

[a]Sampled during present investigation.

shipping quarries in Illinois

Daily production	Uses	Topographic position	Height of quarry face	Average overburden
Tons			*Feet*	*Feet*
100	Aggregate, agricultural limestone, lime	River bluff...	75	Mining method used
50±	Mainly agricultural limestone, lime, some crushed stone	River bluff...	55	18-20. (Increases back from face)
50	Lime, agricultural limestone, aggregate. Mainly agricultural lime (lime); some crushed stone	River bluff...	70	15. Mining method used also
20	Mainly agricultural limestone and lime	River bluff...	55	20. Mining method used also
....	Roads, concrete aggregate, agricultural limestone	River bluff...	40	14.
100	Concrete aggregate, road material, agricultural limestone	Pit..........	38	....
200-250	Agricultural limestone, road material, concrete aggregate	Pit..........	5	1
....	Concrete road material, agricultural limestone	Pit..........	32	12
1500	Concrete road materials, agricultural limestone, ballast	Pit..........	22	2
1200	Concrete roads, railroad ballast, agricultural limestone	Pit..........	57	1½
4000	Concrete, roads, railroad ballast, agricultural limestone	Pit..........	30-50	3

TABLE 7.—*List of shipping*

Reference No.	Location		Operator	Daily capacity of plant	Railroads
	County	Town			
				Tons	
L No. 143..	Cook.......	Lyons......	Riverside Lime and Stone Company	Not working, capacity reported to be 25 cars	Chicago and Joliet Electric
L No. 144..	Cook.......	Chicago....	Federal Stone Company	3000	Indiana Harbor Belt
L No. 145..	Cook.......	Gary.......	Dolese and Shepard	5000	Switch to Hawthorne to Elgin, Joliet and Eastern; Belt Railroad
L No. 146..	Cook.......	LaGrange..	Superior Stone Company	....	Indiana Harbor Belt; truck
L No. 147..	Cook.......	Chicago....	Stearns Lime Company, 28 and Lime St.	....	Truck ....
L No. 148..	Cook.......	Chicago....	Chicago Union Lime Works	....	Truck ....
L No. 149..	Cook.......	Chicago....	Consumers Company (formerly Producers Stone Company)	....	Truck ....
L No. 151..	Cook.......	Bellewood..	O'Laughlin Stone Company	....	Chicago and Great Western
L No. 150..	Dupage.....	Elmhurst...	Elmhurst Chicago Stone Company	2000	Chicago and North Western
K No. 92...	Greene.....	Eldred.....	Eldred Stone Company	200	Chicago and Alton ....
L No. 350..	Hardin.....	Shetlerville.	Golconda Portland Cement Company	4 cars crushed rock, 4 cars rip rap	Illinois Central..
L No. 427..	Hardin.....	Shetlerville.	Southern Illinois Limestone Company	500	Illinois Central..
K No. 125.	Henderson..	Gladstone..	Monmouth Stone Company	2000	Chicago, Burlington and Quincy

quarries in Illinois—Continued

Daily production	Uses	Topographic position	Height of quarry face	Average overburden
Tons			*Feet*	*Feet*
....	Roads, concrete, lime...	Pit..........	52	9
....	Concrete roads, ballast, agricultural limestone	Pit..........	60	2
3000	Concrete, road materials ballast, agricultural limestone, limestone dust	Pit..........	70	10
1000	Concrete, roads, agricultural limestone	Pit..........	60	4
200	Lime, crushed stone.....	Pit..........	200	None
500	Concrete roads	Pit..........	340	None
400	Concrete, roads, agricultural limestone, limestone dust	Pit..........	265	None
2400	Concrete, roads, railroad ballast, agricultural stone, ground stone	Pit..........	105	5
1000	Agricultural limestone, road material, concrete, ballast	Pit..........	70	12
80-90	Agricultural limestone...	River bluff...	70±	8-10, but increases back from face
....	Agricultural limestone, road material, concrete, railroad ballast, riprap, bridge stone	In end of hill.	10-40	Thin
500	Agricultural limestone, ballast, aggregate, riprap	Hill side.....	80	Very thin
....	Agricultural limestone, road material, aggregate, railroad ballast	River bluff...	50	30±

TABLE 7.—*List of shipping*

Reference No.	Location		Operator	Daily capacity of plant	Railroads
	County	Town			
				Tons	
K No. 83..	Jersey......	Elsah......	Western Whiting Manufacturing Company	175	Chicago, Peoria and St. Louis..
K No. 81..	Jersey......	Grafton....	Columbia Quarry Company, Quarry No. 4	450	Chicago, Peoria and St. Louis
K No. 37..	Johnson....	Chasco.....	Charles Stone Company	1000	Chicago and Eastern Illinois
L No. 108..	Kankakee..	Kankakee..	Lehigh Stone Company	7000	Chicago, Indiana and Southern
L No. 60...	Madison....	Alton......	Mississippi Lime and Material Company	100	Chicago, Peoria and St. Louis
L No. 61...	Madison....	Alton......	Reliance Quarry and Construction Company	250	Chicago and Alton
L No. 63...	Monroe.....	Columbia (¾ mile east of)	Columbia Quarry Company, Quarry No. 2	900	Mobile and Ohio
L No. 68[a]..	Monroe.....	Valmeyer (¾ mile north of)	Columbia Quarry Company, Quarry No. 3	1400	Missouri Pacific
L No. 351..	Monroe.....	Valmeyer...	Valmeyer Limestone and Stone Company	....	Missouri Pacific
L No. 425..	Montgomery	Litchfield (1½ miles east)	Kiggins Crushed Stone Company	350	Illinois Traction Company
K No. 106.	Pike.......	Pearl.......	Chicago and Alton	500±	Chicago and Alton
K No. 8[a]...	Randolph...	Menard.....	Penitentiary (2 quarries)	....	Missouri Pacific; Illinois Southern; Wabash, Chester and Western
L No. 420..	Rock Island.	Moline.....	Bettendorf Stone Company	250	Chicago, Milwaukee and St. Paul; Chicago, Burlington and Quincy

[a]Sampled during present investigation.

quarries in Illinois—Continued

Daily production	Uses	Topographic position	Height of quarry face	Average overburden
Tons			*Feet*	*Fect*
150	Agricultural limestone, road material, aggregate, whiting	River bluff...	160	6
450	Riprap, concrete road material, ballast	River bluff...	40	8-40
500	Railroad ballast, agricultural limestone, concrete, road material	End of hill...	110	10
5-6000	Agricultural limestone, road material, aggregate, ballast	Pit..........	40	1-6
1000-1200	Lime, concrete, agricultural limestone, road material	River bluff...	60-80	10-60
100	Concrete, aggregate, whiting, road material, agricultural limestone	Pit..........	62	40
900	Flux, concrete, road material, agricultural limestone	Hillside......	55	15
1400	Flux	River bluff...	135	35
....	Concrete, aggregate, agricultural limestone, railroad ballast	River bluff...	....	....
....	Agricultural limestone, aggregate, road material	Pit..........	10	....
350±	....	....	....	Quarry abandoned in 1924
....	Mainly agricultural limestone, some road material	River bluff...	40	35
150	Flux, sugar refineries, carbide works, agricultural limestone, aggregate	River bluff...	24	Heavy. Rock obtained by mining

Table 7.—*List of shipping*

Reference No.	Location		Operator	Daily capacity of plant	Railroads
	County	Town			
				Tons	
K No. 3	St. Clair	Stolle	Casper Stolle Quarry and Construction Company	1500	Illinois Central
K No. 5	St. Clair	Stolle (¼ mile south)	East St. Louis Stone Company	500	Terminal
L No. 62	St. Clair	Columbia (1½ mile north)	Columbia Quarry Company, Quarry No. 1	....	Mobile and Ohio
K No. 28	Union	Anna	Anna Stone Company	1000	Central Illinois Public Service Electric; Illinois Central
L No. 100	Vermilion	Fairmount	Casparis Brothers	4000-4500	Chicago and Eastern Illinois
L No. 109	Will	Joliet	Swan, Medin and Company	....	Michigan Central
L No. 110	Will	Joliet	Western Stone Company	1000±	Elgin, Joliet and Eastern; Chicago and Alton; Michigan Central
L No. 111[a]	Will	Joliet	Markgraf Stone Company	800	Chicago, Rock Island and Pacific
L No. 112[a]	Will	Joliet	Lincoln Crushed Stone Company	1000	Chicago and Alton
....	Will	Joliet	Inland Crushed Stone Company	400 (estimate)	Chicago and Alton
L No. 113	Will	Joliet	National Stone Company	....	Chicago and Alton
L No. 114	Will	Joliet	Gross and McCowan Lumber Company	....	Elgin, Joliet and Eastern
L No. 135	Will	Joliet	Illinois State Penitentiary	750	Elgin, Joliet and Eastern

[a]Sampled during present investigation.

quarries in Illinois—Continued

Daily production	Uses	Topographic position	Height of quarry face	Average overburden
Tons			*Feet*	*Feet*
600	Railroad ballast, agricultural limestone, concrete, road material	River bluff...	70	10
450	Railroad ballast, concrete, agricultural limestone, road material, road	River bluff...	65	18
3400	Agricultural limestone, concrete, road material	Hillside......	85	15
2000	Railroad ballast, concrete, agricultural limestone, road material	Hillside......	75	12
500	Flux, cement	Pit..........	16-20	16-20
....	Building stone	Pit..........	10±	8
Not operating since 1913	Agricultural limestone, road material, concrete, rubble, ballast	Pit..........	45	3
500	Agricultural limestone, concrete, road material ballast	Pit..........	45	9 inches
800	Agricultural limestone, concrete, road material, ballast	Pit..........	40	1½
Not operating	Rubble, agricultural limestone, concrete, road material	Pit..........	32	2
1200-1500?	Rubble, ballast, agricultural limestone, concrete, road material	Pit..........	63	2½
....	Riprap, building stone	Pit..........	35	8
140	Agricultural limestone, concrete, road material	Pit..........	38	2

TABLE 7.—*List of shipping*

Reference No.	Location		Operator	Daily capacity of plant	Railroads
	County	Town			
				Tons	
L No. 294..	Winnebago.	Rockford...	Carrico Stone Company (formerly Northern Illinois Supply Company)	350	Chicago, Milwaukee and St. Paul
L No. 295..	Winnebago.	Rockford...	Northern Illinois Supply Company (formerly Hart and Page)	500	Chicago, Milwaukee and St. Paul

quarries in Illinois—Concluded

Daily production	Uses	Topographic position	Height of quarry face	Average overburden
Tons			*Feet*	*Feet*
200	Agricultural limestone, concrete, roads	Pit..........	50	8
150-200	Agricultural limestone, concrete, roads, lime	Pit..........	100	2

TABLE 8.—*Promising sites for*

Reference No.	Location		Railroad	Topographic position	Amount available
	County	Town			
K No. 114...	Adams.....	....	Chicago Burlington and Quincy	River bluff...	Large
K No. 65....	Alexander..	Thebes (Half a mile south)	Chicago and Eastern Illinois	River bluff...	Large
L No. 315[a], L No. 316[a]	Carroll.....	Savanna....	St. Louis, Missouri and Southern	River bluff...	Immense
L No. 33, L No. 34, L No. 35	Clark......	Marshall...	Big Four	Stream valley	Unlimited
L No. 140...	Cook.......	Chicago....	Santa Fe	River bluff...	Large
L No. 140a..	Cook.......	Lemont....	Chicago and Alton	River flood-plain	Large
L No. 140b..	Cook.......	Lemont....	Chicago and Alton	River flood-plain	Large
L No. 140c..	Cook.......	Chicago....	Chicago Rock Island and Pacific; Indiana Harbor Belt	Isolated hill..	Large
K No. 91....	Greene.....	Eldred.....	Chicago and Alton	River bluff...	Large
K No. 92, K No. 93	Greene.....	Hillview....	Chicago and Alton	River bluff...	Large
L No. 175...	Grundy.....	....	Chicago Rock Island and Pacific	Flat.........	Large
L No. 176[a]..	Grundy.....	....	Eastern Joliet and Eastern	Flat.........	Large
K No. x[a]....	Hardin.....	North of Shetlerville	Illinois Central	End of hill...	Unlimited
L No. 90[a]...	Jackson....	Grand Tower (½ mile north)	Illinois Central	End of ridge..	1,000,000+ tons
K No. 125...	Jackson....	North of Grand Tower	Illinois Central	Ridge.......	Immense
....	Jo Daviess..	....	Illinois Central; Chicago, Northwestern; Chicago Great Western; Chicago, Burlington and Quincy	River bluff...	Immense

[a]Sampled during present investigation.

shipping quarries in Illinois

Exposed thickness	Overburden		Character of rock	Geologic formation	Remarks
	Thickness	Kind			
Feet	*Feet*				
25-70	30-50	Loess.....	Coarse-grained..	Keokuk-Burlington	....
70	20-40	Sandstone	Coarse-grained..	Kimmswick......	....
240	20-33	Loess.....	Porous.........	Niagaran........	....
15±	10-15	Sandy clay till	Compact........	McLeansboro.....	Land partly under cultivation
45	10-25	Till.......	Fine-grained....	Niagaran........	225,000 yards ± 10 feet overburden
....	5—	Loam.....	Fine-grained....	Niagaran........	....
....	3—	Loam.....	Fine-grained....	Niagaran........	....
30	9-15	Till.......	Coarse-grained, bituminous	Niagaran........	Blue Island
70	8-30	Loess.....	Coarse-grained..	Burlington.......	Considerable chert
30-80	0-30	Loess.....	Coarse-grained..	Burlington.......	....
150	10—	Soil......	Dense..........	Galena...........	Thickness of Galena from well record
12	5—	Soil.......	Coarsely crystalline	Maquoketa.......	Possibly 60 feet thick
75±	0-10	Soil and loess....	Oolitic to compact	Renault, Ste. Genevieve	Land unfit for cultivation
53+	20±	Loess.....	Crystalline to compact	Salem and St. Louis	Rock dips 30 degrees. Formerly quarried for railroad ballast etc.
60±	Thin	Loess.....	Compact, finely granular	Devonian........	Known as the "Back Bone".
60-120	10-40	Loess.....	Coarse-grained..	Galena...........	Mississippi River bluffs

TABLE 8.—*Promising sites for shipping*

Reference No.	Location		Railroad	Topographic position	Amount available
	County	Town			
....	Jo Daviess..	....	Chicago, Burlington and Quincy; Chicago, North western	River bluff...	Immense
K No. 29[a]...	Johnson....	Bloomfield..	Chicago, Cleveland, Cincinnati, and St. Louis	Valley flat....	Large
K No. 31....	Johnson....	Belknap....	Big 4	End of hill...	500,000+ tons
K No. 33b...	Johnson....	Buncombe..	Chicago and Eastern Illinois	Hillside......	2,500,000+ tons
K No. 82....	Jersey......	Grafton....	Chicago, Peoria and St. Louis	River bluff...	Large
K No. 85....	Jersey......	Elsah......	Chicago, Peoria and St. Louis	River bluff...	Large
L No. 101...	Kankakee..	Aroma.....	Chicago, Cleveland, Cincinnati, and St. Louis	Flat.........	Large
L No. 102...	Kankakee..	Momence...	Chicago and Eastern Illinois	Flat.........	Large
L No. 182, 183[a]	LaSalle.....	Troy.......	Chicago and Northwestern	Valley sides.	Large
L No. 184...	LaSalle.....	Sheridan...	Chicago, Burlington and Quincy	Valley sides.	Moderately large
L No. 11....	Lee........	Dixon......	Illinois Central....	Rock River bluff	Immense
L No. 12....	Lee........	Dixon......	....	Bluffs north of cement plant	Immense
L No. 203[a]...	Lee........	Dixon......	Chicago and Northwestern	Hill.........	500,000 yards
L No. 210...	Lee........	Dixon......	Chicago and Northwestern	Hill.........	1,000,000 yards
L No. 218...	Lee........	Dixon......	Chicago and Northwestern	Hill.........	750,000 yards
L No. 219...	Lee........	Dixon......	Chicago and Northwestern	Hill.........	1,000,000 yards
L No. 221...	Lee........	Dixon......	Chicago and Northwestern	Hill.........	750,000 yards
L No. 232...	Lee........	Dixon......	Chicago and Northwestern	Flat.........	Large

[a]Sampled during present investigation.

quarries in Illinois—Continued

Exposed thickness	Overburden		Character of rock	Geologic formation	Remarks
	Thickness	Kind			
Feet	*Feet*				
60-140	10-40	Loess.....	Coarse-grained..	Galena...........	Galena River bluffs
....	8±	Loess.....	Fine-grained, compact	Kinkaid..........	Construction of spur to railroad rather difficult
40+	0-30+	Talus, shale, sandstone	Oolitic, crystalline and compact	Ste. Genevieve....	Land unfit for agriculture
80+	10-15	Soil and loess	Compact, cherty, contains some shale	Kinkaid..........	Flat on hill. Under cultivation
40	10-30	Loess.....	Fine-grained....	Niagaran.........	....
150	15-50	Loess.....	....	....	....
5	3-8	Soil......	Weathered......	Niagaran.........	Poor exposure; rock thicker
50	5-8	Soil......	Fine-grained....	Niagaran.........	Poor exposure; water filled quarry
12	10–	Soil......	Fine-grained....	Galena-Trenton...	....
25	5–	Clay till...	Fine-grained....	Galena-Trenton...	....
60-100	15–	Till.......	Fine-grained....	Platteville........	Thin Galena capping
60-80	Moderately large	Till.......	Fine-grained....	Platteville........	....
16	10–	Till.......	Fine-grained soft	Galena...........	Rock over 30 feet thick
30	5-15	Till.......	Coarse-grained..	Galena...........	....
30	10–	Till.......	Coarse-grained..	Galena...........	....
....	5–	Till.......	Coarse-grained..	Galena...........	....
22	10–	Loam.....	Coarse-grained..	Galena...........	....
42	4-7	Soil......	Fine-grained....	Galena...........	....

TABLE 8.—*Promising sites for shipping*

Reference No.	Location		Railroad	Topographic position	Amount available
	County	Town			
L No. 59....	Madison....	North of Alton	Chicago, Peoria and St. Louis	River bluff...	Unlimited
L No. 55 } L No. 56 }	Massac.....	Mermet...	Chicago, Burlington and Quincy	Ridge........	Large
K No. 27b...	Monroe.....	South of Valmeyer	Missouri Pacific...	River bluff...	Unlimited
L No. 202[a]..	Ogle.......	Oregon.....	Chicago, Burlington and Quincy	Hills.........	Immense
L No. 239[a]..	Ogle.......	Leaf River..	Chicago, Milwaukee and St. Paul	Ridge........	Large
L No. 250...	Ogle.......	Oregon.....	Chicago, Burlington and Quincy	Hill.........	400,000 yards
L No. 252[a]..	Ogle.......	Polo.......	Chicago, Burlington and Quincy	Bluff........	Immense
L No. 261...	Ogle.......	....	Chicago, Burlington and Quincy	Bluff........	Large
L No. 262...	Ogle.......	....	Chicago, Burlington and Quincy	Bluff........	Large
L No. 263...	Ogle.......	Leaf River..	Chicago, Milwaukee and St. Paul	Hill.........	Moderately large
L No. 266[a]..	Ogle.......	Adeline....	Chicago, Milwaukee and St. Paul	Bluff........	Immense
L No. 271[a]..	Ogle.......	Byron......	Chicago, Milwaukee and St. Paul	Hill.........	Immense
....	Ogle.......	The Pines...	Chicago, Burlington and Quincy	Pine Creek bluff	Large
K No. 107...	Pike.......	Valley City.	Western	River bluff...	Large
K No. 108...	Pike.......	Valley City.	Western	Creek bluff...	Large
K No. 109...	Pike.......	Valley City.	Western	Bluff.........	Large
K No. 110...	Pike.......	Barry......	Western	Creek bluff...	Large
K No. 61....	Pulaski.....	Ullin.......	Illinois Central....	Narrow ridge.	Large
K No. 26[a]...	Randolph...	Prairie du Rocher (1 mile north)	Missouri Pacific spur	Creek bluff...	2,000,000+ tons
K No. 9.....	Randolph...	North of Prairie du Rocher	Missouri Pacific ..	River bluff...	Immense
K No. 95....	Scott.......	Glasgow....	Chicago, Burlington and Quincy	Low ridge....	Large
K No. 4.....	St. Clair....	Stolle to south of Falling Spring	Terminal	River bluff...	Unlimited

[a]Sampled during present investigation.

quarries in Illinois—Continued

Exposed thickness	Overburden		Character of rock	Geologic formation	Remarks
	Thickness	Kind			
Feet	*Feet*				
70+	40±	Loess.....	Oolitic to compact (lithographic)	Ste. Genevieve and St. Louis	Whole bluff north of Alton offers possibilities
26	10	Residual soil	Compact........	St. Louis.........	....
100+	0-80	Loess.....	Compact; some chert	St. Louis.........	....
40	15–	Till.......	Fine-grained....	Platteville.......	....
20	10–	Till.......	Coarse-grained..	Platteville.......	....
35	10–	Till.......	Fine-grained....	Lower-Magnesian.	....
60-80	10±	Till.......	Fine-grained....	Galena-Platteville.	....
50-60	10–	Till.......	Coarse-grained..	Galena..........	....
45	10-15	Till.......	Coarse-grained..	Galena..........	....
10	15–	Till.......	Fine-grained....	Platteville.......	Chert common
120	15–	Till.......	Fine-grained....	Galena..........	....
61	10–	Till.......	Fine-grained....	Platteville.......	....
60	20–	Till.......	Coarse-grained..	Galena..........	....
50	15	Loess.....	Coarse-grained..	Burlington.......	....
30+	5–	Loess.....	Coarse-grained..	Burlington.......	....
50-75	10-30	Loess.....	Coarse-grained..	Burlington.......	....
80	15	Loess.....	Coarse-grained..	Burlington.......	....
25-60	8-15	Loess.....	Granular........	Salem..........	....
90+	30±	Loess....	Compact; cherty in spots	St. Louis.........	Land under cultivation
100-200	40-100	Loess....	Compact........	St. Louis.........	....
25	5-15	Loess.....	Coarse-grained..	Burlington.......	Former Railroad quarry
80+	20-40+	Loess.....	Compact........	St. Louis.........	Land near bluff not cultivated

TABLE 8.—*Promising sites for shipping*

Reference No.	Location		Railroad	Topographic position	Amount available
	County	Town			
L No. 299...	Stephenson.	Scioto Mills.	Illinois Central ...	Hill.........	Moderately large
L No. 304...	Stephenson.	Orangeville.	Illinois Central....	Hill.........	Moderately large
L No. 307...	Stephenson.	Baileyville..	Illinois Central....	Creek bluff...	Moderately large
L No. 309...	Stephenson.	German Valley	Chicago, Great Western	Hill.........	Moderately large
L No. 311...	Stephenson.	....	Chicago, Milwaukee and St. Paul	Hill.........	Moderately large
L No. 312...	Stephenson.	Rock City..	Chicago, Milwaukee and St. Paul	Hill.........	Moderately large
L No. 400...	Stephenson.	Freeport...	Chicago, Northwestern	Hill.........	Large
L No. 401...	Stephenson.	Davis......	Chicago, Northwestern	Hill.........	Moderately large
L No. 402...	Stephenson.	Buena Vista	Illinois Central....	Hill.........	Large
L No. 403...	Stephenson.	McConnell..	Illinois Central....	Bluff........	Immense
L No. 404...	Stephenson.	Orangeville.	Illinois Central....	Bluff........	Large
L No. 405...	Stephenson.	Buena Vista	Illinois Central....	Hill.........	Large
K No. 71....	Union......	Kaolin.....	Mobile and Ohio...	Ridge........	Moderately large
L No. 10....	Whiteside..	North of Fulton	Chicago, Burlington and Quincy, Chicago, Milwaukee and St. Paul	Bluff........	Large
L No. 130...	Will........	Drummond.	Atchison, Topeka and Santa Fe; Chicago and Alton	Flat.........	Large
L No. 278...	Winnebago.	Harlem.....	Chicago, and Northwestern	Bluff........	Large
L No. 279[a]...	Winnebago.	Rockton....	Chicago, Milwaukee and St. Paul	Hill.........	Large
L No. 282...	Winnebago.	Shirland....	Chicago, Milwaukee and St. Paul	Hill.........	Moderately large
L No. 291...	Winnebago.	Durand.....	Chicago, Milwaukee and St. Paul	Hill.........	Large
L No. 298...	Winnebago.	Rockford...	Chicago and Northwestern; Illinois Central	Hill.........	Moderately large

[a]Sampled during present investigation.

quarries in Illinois—Concluded

Exposed thickness	Overburden Thickness	Overburden Kind	Character of rock	Geologic formation	Remarks
Feet	*Feet*				
27	10—	Till.......	Coarse-grained..	Galena..........	....
27	6-10	Till.......	Earthy.........	Platteville.......	....
28	5—	Till.......	Hard...........	Platteville or Galena	....
30-40	10-15	Till.......	Hard...........	Galena...........	Railroad on embankment
27	10—	Till.......	Coarse-grained..	Galena...........	Railroad cut
36	10—	Till.......	Coarse-grained.	Galena..........	....
40	Small	Till.......	Coarse-grained.	Galena..........	....
41	15—	Till.......	Coarse-grained..	Galena..........	....
75	10—	Till.......	Coarse-grained..	Galena..........	....
20-55	5—	Till.......	Coarse-grained..	Galena..........	....
25	10—	Till.......	Fine-grained....	Platteville.......	....
200	3—	Soil......	Coarse-grained..	Galena...........	Thickness in wells
30+	10	Loess.....	Medium-grained.	Burlington.......	....
50-85	0-50	Largely very fine sand or sandy clay	Medium grained porous	Niagaran.........	Mississippi River bluffs
24	5—	Soil......	Fine-grained....	....	100 feet limestone in wells
45	5-15	Till.......	Coarse-grained..	Galena..........	....
50	10—	Till.......	Fine-grained....	Platteville........	Rockford Interurban Electric
40	10—	Till.......	Fine-grained....	Platteville.......	....
30	5-20	Till.......	Fine-grained....	Platteville.......	....
40	10—	Till.......	Coarse-grained..	Galena..........	....

CHAPTER VII.—LIMESTONE RESOURCES OF ILLINOIS—THE NORTHERN DISTRICT

By J. E. Lamar

The northern district (see fig. 1) is composed of the counties in which Ordovician and Silurian rocks are the predominant bed rocks. Outcrops of limestone are abundant in parts of this region and the greater part of the road material produced in Illinois comes from quarries located therein. The counties of this area are described in alphabetical order as follows:

Boone	Lake
Carroll	LaSalle
Cook	Lee
DeKalb	McHenry
DuPage	Ogle
Grundy	Stephenson
Jo Daviess	Whiteside
Kane	Will
Kankakee	Winnebago
Kendall	

BOONE COUNTY

Good outcrops of limestone are few in Boone County (fig. 38, p. 197), and those observed were of two kinds only, the Edgewood limestone and Galena dolomite. Both formations have been worked extensively in the past as a source of dimension stone, but at present only the Galena is being quarried.

SHIPPING QUARRIES

L. No. 276

Belvidere Crushed Stone Company

The quarry of the Belvidere Crushed Stone Company is located in a gently rolling prairie about 1¼ miles west of Belvidere, in the NW. ¼ SW. ¼ NE. ¼ sec. 34, T. 44 N., R. 3 E. It is worked as a pit and is roughly oval in outline, 350 feet long, and about 200 feet wide. A 38-foot face of Galena dolomite is being quarried.

The rock varies markedly in the quarry. The upper portion which has been subjected to the activities of surface water is brown and porous. The stone below the weathered portion, however, is medium coarsely or finely crystalline, moderately hard, dense (particularly in certain beds), gray dolomite, occurring in beds from 3 to 24 inches in thickness and averaging about 12 inches.

In quarrying, the holes for the heavy blasting are made with a well drill and the entire face of 38 feet shot down at one time. The broken stone is loaded into quarry cars by hand, pushed to the incline, and pulled up to the crusher by cable.

The crushing apparatus consists of a No. 4 Gates crusher operated by an electric motor, and four cylindrical screens. Any sized stone can be produced but the output is being used as road material and is therefore crushed to 1¾-inch size and screenings. Storage is afforded by bins with a capacity of about 350 cubic yards. The daily production is about 100 yards.

Transportation is furnished by the Rockford and Interurban Electric, by the Chicago and Northwestern Railroad, and by motor truck.

LOCAL QUARRY SITES

Sec. 14, T. 43 N., R. 3 E.

Limestone has been quarried for building purposes in the center of the west half of sec. 14, T. 43 N., R. 3 E., south of Belvidere. The exposure is rather extensive and a chain of quarries covers almost a quarter of a mile. About 18 feet of Edgewood limestone is exposed. The stone is a dense, fine-grained, rather soft, argillaceous limestone in beds ranging from one to five inches in thickness. This outcrop is about three miles from the nearest railroad and is therefore of interest only as a local source of road material.

CARROLL COUNTY

TOPOGRAPHIC RELATIONS

The general topography of Carroll county is, for the most part, roughened by stream erosion. All of the county (fig. 6) has not been glaciated, and where the glacial drift is missing in places the loess mantles the underlying bed rock. The thickness of the loess is variable but in general it is greatest near Mississippi River. The best limestone exposures are found in and near the Mississippi River bluff particularly north of Savanna, where as much as 240 feet of limestone is exposed in an almost sheer bluff.

THE ROCK FORMATIONS

The Galena dolomite.—The oldest rock exposed in Carroll County is the Galena dolomite. It outcrops near Mount Carroll in a small quarry just south of the main part of town, and along Carroll Creek for about three-quarters of a mile in the E. ½ of sec. 2, T. 24 N., R. 4 E., about a mile west of Mount Carroll. Two other small exposures are found at the crossing of the Indian Head Trail and Plum Creek, just east of Savanna in sec. 2, T. 24 N., R. 3 E. and in the cen. SE. ¼ sec. 18, T. 24 N., R. 4 E. halfway between Savanna and Wacker.

The Maquoketa shale.—The only exposure of this formation seen is in the bluff north of Savanna, where a local upbowing of some of the strata has resulted in the appearance of the shale for a short distance. The Maquoketa as exposed is a compact, earthy, gray-buff shale occurring in rather heavy beds, with occasional thin beds of calcareous shale or shaly limestone.

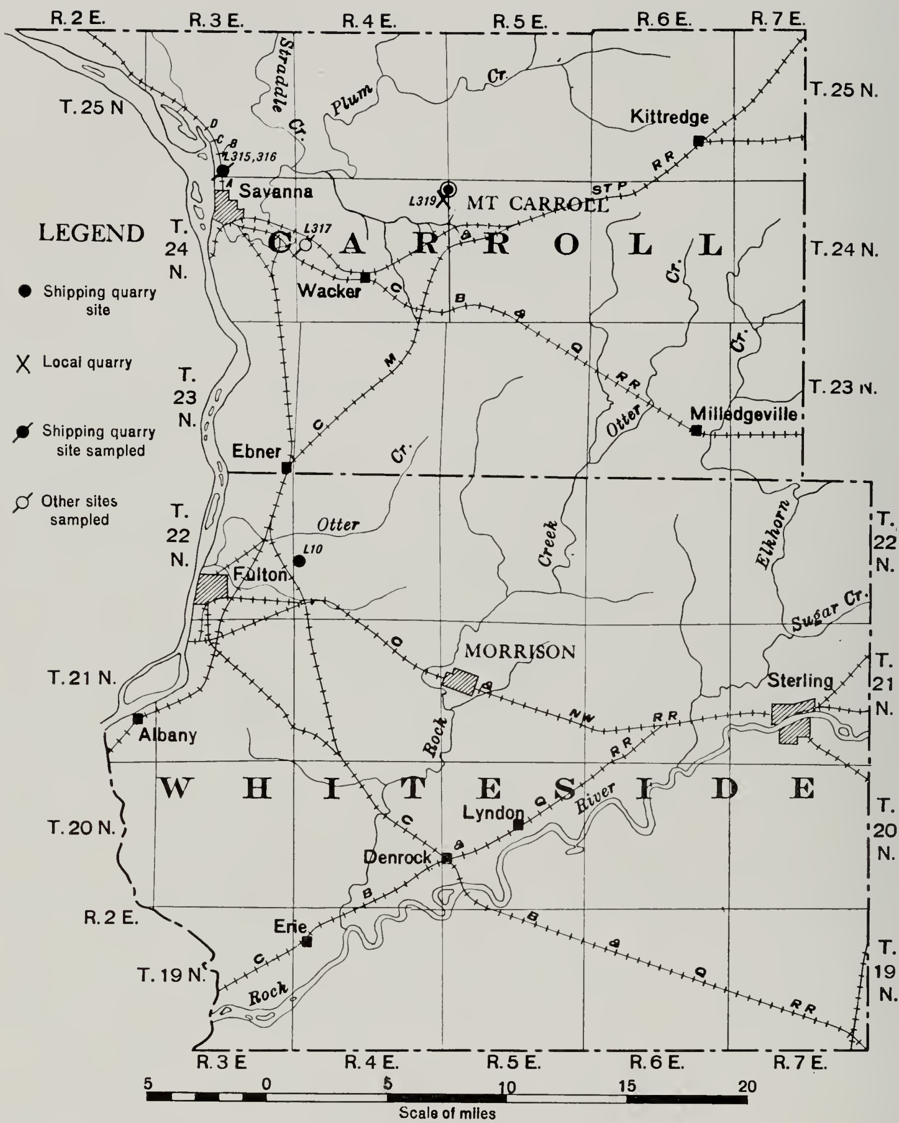

Fig. 6. Map of Carroll and Whiteside counties showing location of quarries and quarry sites.

The Niagaran dolomite.—This formation consists of a porous, buff, magnesian limestone, containing nodules and bands of chert, especially in the lower part. The bedding varies, but is commonly heavy, the beds ranging in thickness from 4 to 6 feet.

SHIPPING QUARRIES

There are no shipping quarries in this county.

SITES FOR SHIPPING QUARRIES

L. Nos. 315 and 316

The best sites for shipping quarries are located in the bluff extending north of Savanna for about three miles (fig. 7). In this bluff the best sites are to be found in that part extending north of Savanna for about three-quarters of a mile. Here the bluff reaches its maximum height, with a thickness of 240 feet of rock, measured above Mississippi River (fig. 8A).

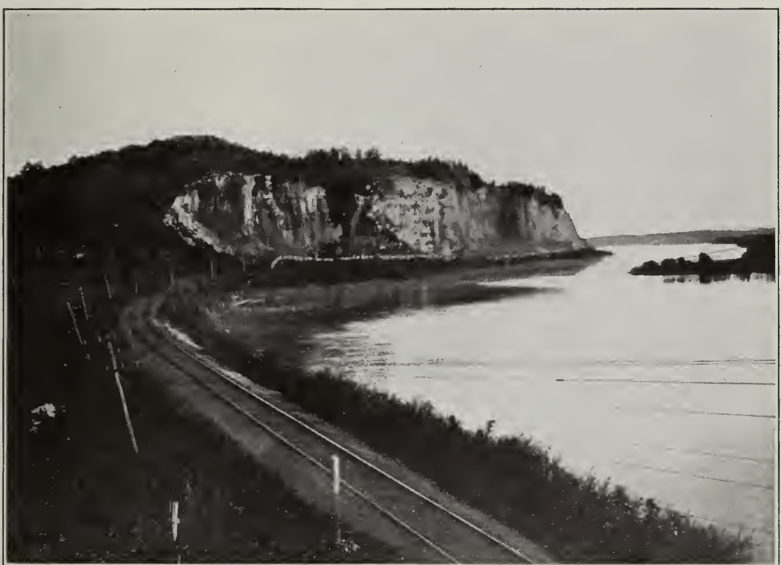

FIG. 7. Bluffs of the Mississippi River one mile north of Savanna, showing the Niagaran dolomite.

Here the Maquoketa shale is absent from the bluff, so far as could be observed. The overburden is loess and sandy loess, which at a road cut on the top of the bluff is 33 feet thick, probably the maximum thickness in this area. By quarrying in places on top of the bluff where some of the loess has been removed by gullying, the average overburden might be reduced to about 25 feet.

The rock is Niagaran dolomite. Samples L No. 315 and L No. 316 were obtained from different portions of this formation, and represent the rock as a road material. The stone, however, might test somewhat higher if samples could be obtained from a quarry which had worked back into the unexposed rock.

Some difficulty might be encountered in finding sufficient space for a switch since the road and the railroad closely parallel each other and at present occupy all the available area at the bottom of the bluff. However, removal of the talus at the base of the escarpment would provide ample space for a switch track, and probably for a crushing plant.

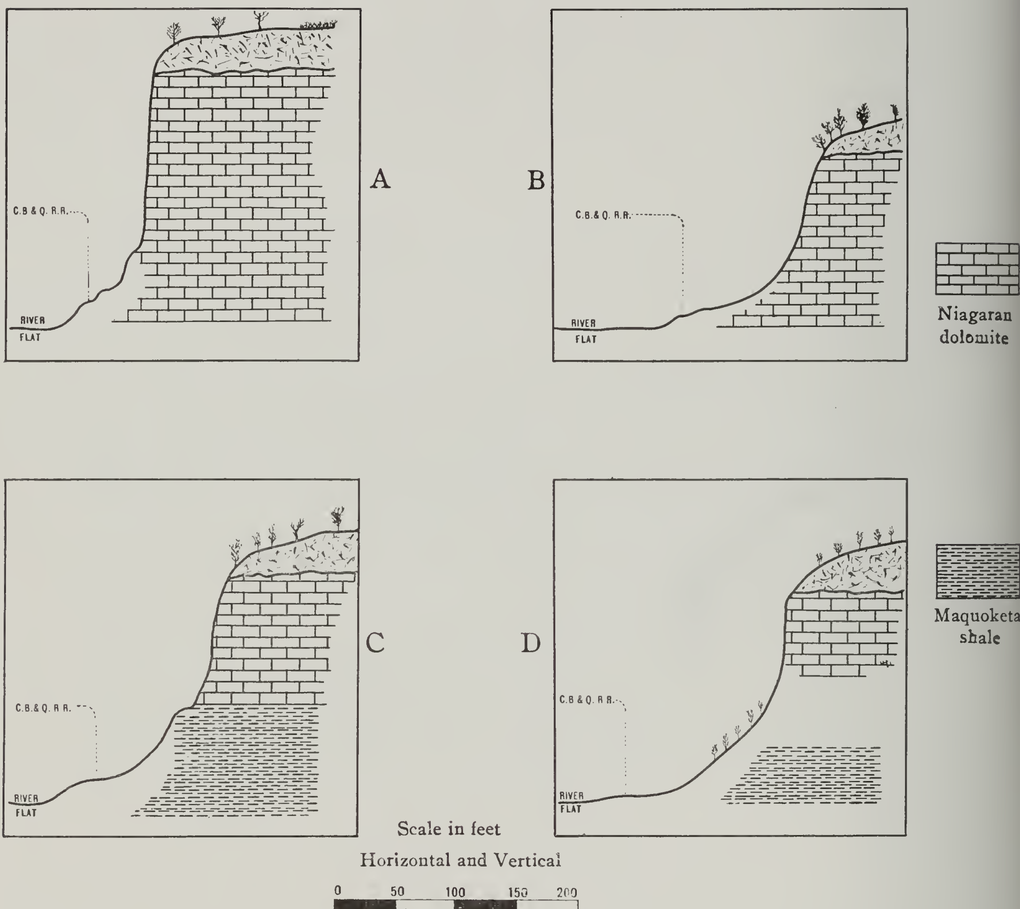

Fig. 8. Diagrammatic cross sections of the Mississippi River bluff north of Savanna, designated on figure 6 as *A*, *B*, *C* and *D*.

A. Cen. E. ½ E. ½ sec. 4, T. 24 N., R. 3 E.
B. NW. cor. sec. 34, T. 25 N., R. 3 E.
C. Cen. E. ½ sec. 28, T. 25 N., R. 3 E.
D. NE. ¼ sec. 28, T. 25 N., R. 3 E.

LOCAL QUARRIES

L. No. 319

NW. ¼, SE. ¼, SE. ¼ sec. 1, T. 24 N., R. 4 E.

As far as observed, only one local quarry in the county has crushing machinery. It is located on the outskirts of Mount Carroll and is equipped with an American Road Machine jaw crusher and a bucket belt elevator. The quarry is not operating, but is in good condition and could be put into operation on relatively short notice. The minimum thickness of overburden is 10 feet. About an acre is available with an average of 18 feet of overburden and 26 feet of rock.

LOCAL QUARRY SITES

L. No. 317

Cen. N. ½ SW. ¼ sec. 18, T. 24 N., R. 4 E.

The small quarry 2 miles southeast of Savanna has exposed 32 feet of fine-grained, dense, hard, tough, buff-pink dolomite, in beds averaging about 8 inches in thickness at this place. An ample local supply is available from an area having less than 5 feet of overburden.

SE. ¼ SE. ¼ SW. ¼ sec. 10, T. 24 N., R. 4 E.

A small quarry located 3½ miles southwest of Mt. Carroll along the bank of Cedar Creek exposes 19 feet of fine-grained, finely crystalline, hard, dense, tough, brown Galena dolomite, in beds averaging about 6 inches in thickness. About 3,000 yards are available with less than 5 feet of overburden.

SW. ¼ NW. ¼ SE. ¼, sec. 2, T. 24 N., R. 3 E.

About one mile east of Savanna there is an exposure of 21 feet of Galena dolomite along Plum Creek. The rock is fine-grained, finely crystalline, hard, dense and gray-buff in color. About 5,000 cubic yards are available with less than 5 feet overburden.

The Mississippi River bluffs north of Savanna

These bluffs will furnish a local supply of stone at almost any place in the county, except perhaps near the northern boundary.

COOK COUNTY

TOPOGRAPHIC RELATIONS

The surface of Cook County (fig. 9) is generally level or gently undulating. The latter characteristic prevails in the northern and southwestern portions, but in the extreme northwestern and southern portions of the county the topography becomes broken or even hilly.

THE EXPOSED ROCK FORMATION

The Niagaran dolomite underlies probably the entire extent of Cook County. In the northern part, the exposures are few; in fact, all of the outcrops, with perhaps one exception, are included in that portion of the county lying to the south of a line passing through Elmhurst. To the north of this line the rock is covered by glacial drift. The outcrops of limestone seem to be due to removal of the drift by stream erosion or to the fact that in cases the bed rock constituted prominent elevations in the region before glaciation, and was therefore not deeply buried.

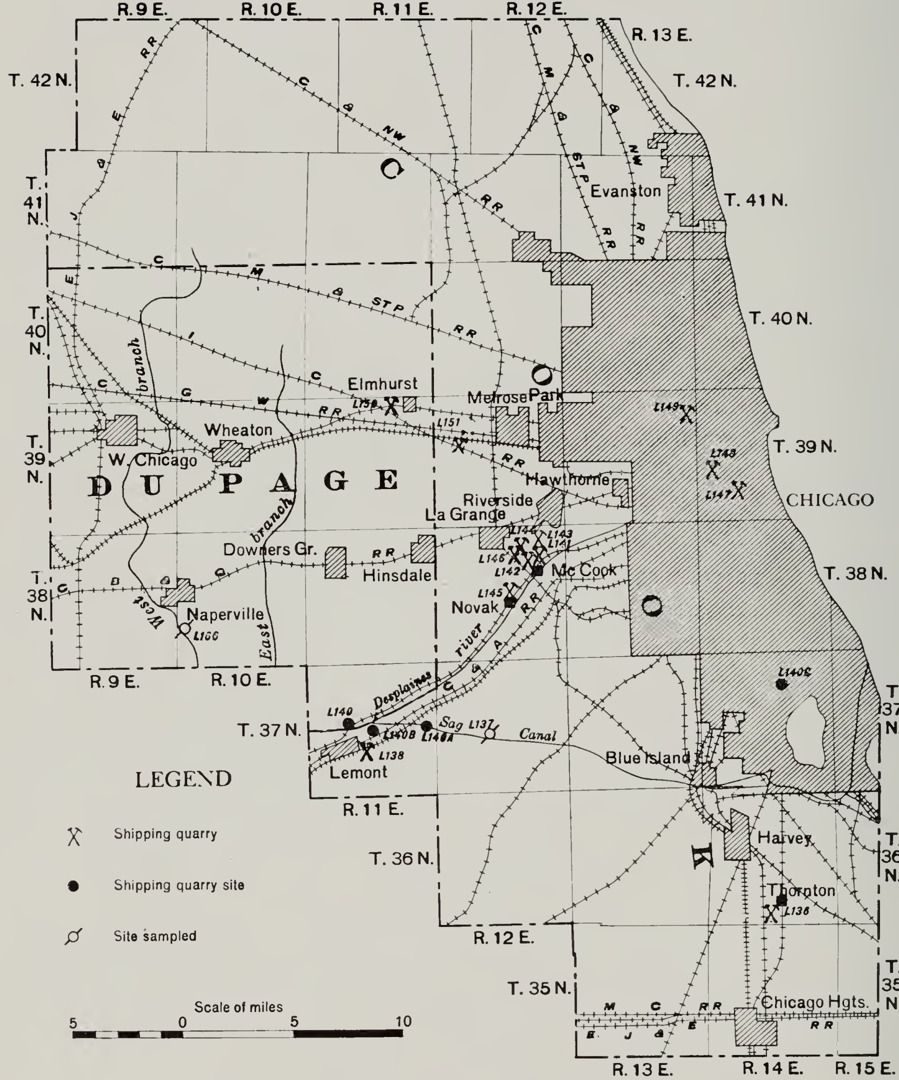

FIG. 9. Map of Cook and Dupage counties, showing location of quarries and quarry sites.

SHIPPING QUARRIES

Large quarries either have been or are located at almost every outcrop of limestone of any consequence in the county. Most of these quarries operate on a large scale and are equipped to crush rock to any size. The market for the crushed stone is to a great extent local, that is, in Chicago and its environs, but considerable shipping is done to the south, to make use of the empty coal cars returning to the mines over the Illinois Central Railroad.

L. No. 136

The Brownell Improvement Company at Thornton
Cen. NW. ¼ SW. ¼ sec. 33, T. 36 N., R. 14 E.

This company operates a rectangular quarry about ¾ of a mile long and ½ mile wide, with a 32-foot face of rock. The overburden consists of gray, sandy or gravelly clay which averages about 12 feet in thickness. The quarry is kept dry by pumps which remove the water from a large sump (fig. 10).

The rock is the Niagaran dolomite, and is a fine-grained, white, hard, brittle stone in beds 2 to 12 inches thick.

The rock is drilled by Clipper electric well drills and the whole face blasted at once with 40 per cent dynamite. Small jack-hammers are used for drilling the holes for the secondary blasting. The rock is loaded into 8-yard quarry cars and pulled by a locomotive to the base of the tipple. From there it is pulled up to the primary crusher by cable (fig. 11).

The primary crusher is an Allis-Chalmers No. 24. From it the rock is run through a screen and back to the secondary crushers, which consist of four Allis-Chalmers No. 7½, four McAllister No. 6 and twelve Allis-Chalmers No. 4. The stone is screened frequently so as to separate a certain size from the remainder. For this purpose four cylindrical screens 6 by 20 feet and ten screens 6 by 25 feet are used. The last ten are double for half their length. For the fine product ten shaker screens with two sets of screenings to each are used. The upper screen of each set has ½-inch mesh and the lower a ⅜-inch mesh. From the screens the stone goes to the bins which have a total capacity of 108 cubic yards (fig. 12). The plant is electrically operated throughout by various sized Allis-Chalmers motors.

The stone is used as road material, concrete aggregate, railroad ballast, and agricultural limestone.

The company has switches to the Baltimore and Ohio and the Chicago and Eastern Illinois railroads.

L. No. 138

Consumers Company, Lemont Quarry
(Formerly the Illinois Stone Company)
Cen. SE. ¼ SE. ¼ sec. 20, T. 37 N., R. 11 E.

The Consumers Company operates a quarry at Lemont. The quarry is oval-shaped, about 2,000 feet long and 1,500 feet wide. A 22-foot face

FIG. 10. Loaded and empty quarry cars at foot of incline hoist in quarry of the Brownell Improvement Company.

FIG. 11. The primary crusher, screen housing and storage bin of the Brownell Improvement Company.

is being worked and from it about two feet of black loam overburden is being removed by steam shovel and motor truck. The quarry is kept dry by two 4- and 6-inch centrifugal pumps.

The rock is the Niagaran dolomite; is moderately hard, porous, gray-white, and occurs in beds averaging 6 inches in thickness.

The rock is drilled by Clipper well drills, and the entire face is shot down at one time with 40 per cent dynamite. In drilling for the smaller shots, jack-hammers are used. The stone is loaded by steam shovel into 6-ton quarry cars, pulled to the incline by locomotives and up to the primary crusher by cable.

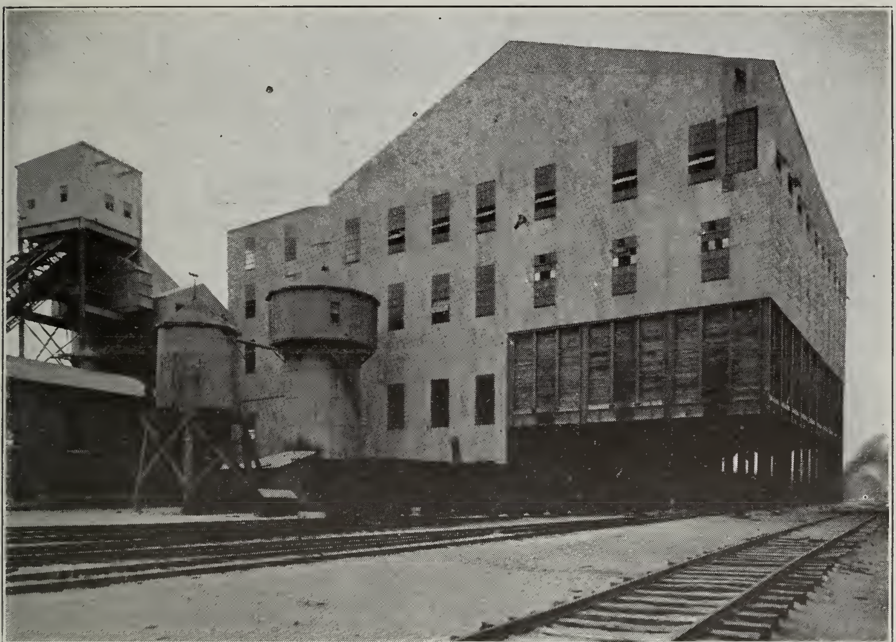

FIG. 12. Close-up view of the screen housing and storage bin of the Brownell Improvement Company.

The primary crusher is a No. 18 Allis-Chalmers. The secondary set consists of a No. 7½ McCully, two No. 4 McCullys, and two No. 4 Allis-Chalmers crushers. The stone is screened between the No. 18 and No. 7½, and again between the latter and the No. 4s with three Power and Mining screens, 4 by 24 feet. Any sized stone can be made, and the product is run from the screens to bins having a total capacity of 800 cubic yards.

The daily production of this plant is about 1500 tons; the annual production about 400,000 tons. Quarrying is carried on for about 8 months of the year.

The stone is used as railroad ballast, concrete aggregate, road stone, and agricultural limestone.

There are switches from the quarry to the Chicago and Joliet Electric Railroad, and the Chicago and Alton Railroad.

L. No. 141

Consumers Company, Summit quarry
(Formerly The Argo Stone Company)

SE. ¼ SW. ¼ NE. ¼ sec. 11, T. 38 N., R. 12 E.

At Summit the Consumers Company operates a quarry which is shaped roughly like a figure 8, with each loop of the 8 about 400 feet in diameter. A 57-foot face is being worked, with an average overburden of approximately 1½ feet. The quarry is kept dry by an electric and a steam pump.

The rock is Niagaran dolomite and is dense, fine-grained, white, and massive, the beds varying in thickness from 3 inches to 3 feet. The hardness apparently increases toward the bottom of the exposure.

The blast holes are drilled with well drills, and the entire face shot down at once. An Ingersoll-Rand and air jack-hammers are used for drilling the holes for the block hole shots. The rock is loaded by hand into 3-ton cars, pulled by a horse to the base of the incline and to the crusher by cable.

The stone passes through a No. 8 McCully, a No. 8 Traylor, a No. 5 McCully and a No. 3 McCully crushers. It is screened between crushers and for this purpose four 20-foot by 40-inch screens, and one 12-foot by 48-inch McCully screen are employed. Any sized stone can be produced. The entire plant is operated by a Quincy-Corliss 350-horse power steam engine.

The daily production is between 1100 and 1200 yards, and can be maintained for 300 days in a year if the demand warrants it.

The stone is used as railroad ballast, concrete aggregate, agricultural limestone, and for road construction.

Shipment is made over a switch to the Santa Fe Railroad and by motor truck.

L. No. 142

Consumers Company, McCook quarry
(Formerly United States Stone Company)

NE. ¼ SE. ¼ SE. ¼ sec. 10, T. 38 N., R. 12 E.

The quarry is being worked as a circular pit with a face of rock varying between 30 to 50 feet in height, and about 10,000 feet long. The clay overburden which has an average thickness of about 3 feet is removed by a steam shovel and cars. The quarry is kept dry by two electric centrifugal pumps.

The rock is the Niagaran dolomite. It is a hard, dense, brittle, gray stone, except where there is an abundance of fossil debris, in which case it is rather porous.

The holes for the heavy blasting are drilled by Clipper well drills and the smaller holes for block hole shots by jack-hammers. The entire face is blasted at one time with 40 per cent dynamite, and the broken stone loaded by steam shovels to 7-yard quarry cars which are pulled to the incline by locomotives. A cable is used to pull the cars to the crusher.

The primary crusher is a set of Edison Rolls, which are operated by a 200-horse power electric motor, and are capable of reducing 7 tons of rock to 9-inch size in 18 seconds. From the crusher the stone is pulled up an incline in a 12-yard skip to a screen, from which it is run through other crushers and screens until reduced to the desired size. The other crushing apparatus consists of two No. 6 McCullys, two No. 4 McCullys, and a No. 8 Gates. One set of rolls is used for crushing the stone to be sold as agricultural limestone. The screening equipment consists of the following rotary screens: two 84 inches by 25 feet, four 48 inches by 25 feet, two 40 inches by 25 feet and three Allwart shaker screens. The 1¾-inch stone is washed to remove any dirt mixed with it. Any size of crushed stone can be produced. The plant is electrically operated throughout by power obtained from the Sanitary District.

The quarry produces 4,000 tons of rock daily and about 1,000,000 tons yearly. The storage capacity of the bins is about 1200 yards.

The stone is used as agricultural limestone, concrete aggregate, road metal, and for railroad ballast.

Switching facilities are furnished by the Indiana Harbor Belt, the Santa Fe, and the Chicago and Illinois Western railroads.

L. No. 149

Sec. 12, T. 39 N., R. 13 E.

Consumers Company, Grand and Campbell Ave. Quarry, Chicago (Formerly the Producers Stone Company)

This quarry is circular in shape, about 500 feet in diameter and 265 feet deep. It occupies a city block. The quarry has been operated for many years and can not be extended laterally because it is hemmed in by city streets. The only alternative is to go deeper and this is being done by working down in 30-foot benches.

As elsewhere in this region, the rock quarried is the Niagaran dolomite. It is a hard, gray-white, somewhat porous, coarsely crystalline dolomite occurring in thin beds varying from 3 to 14 inches which alternate with beds of greater thickness. Thin layers of greenish clay commonly separate the thicker beds of stone.

Four tripod drills are used in drilling holes for the heavy blasting. The smaller drill holes are made with jack-hammers and tripod drills. The entire 30 feet is blasted at one time, and the broken stone is loaded by hand into 3-yard quarry cars which are pushed to the bottom of the incline and pulled to the crusher by a cable.

The stone is first run through an Austin No. 8 crusher, screened and then run through two No. 5 Allis-Chalmers and a No. 3 crusher of the same make until the desired size has been obtained. A rotary screen 48 inches by 20 feet sorts the stone into the various sized products. The screenings are dried and run through a tube mill which reduces them to a fine powder or lime dust. The entire plant is operated by electricity. Its capacity is 400 tons daily.

The stone is used as concrete aggregate, road metal, agricultural limestone, and lime dust. The products are largely consumed locally and are transported by truck and wagon.

L. No. 143

Riverside Lime and Stone Company, Lyons

NE. ¼ SW. ¼ SE. ¼ sec. 2, T. 38 N., R. 12 E.

This company operates an oval-shaped quarry about 800 feet long and 400 feet wide. The face which is 52 feet high and about 1800 feet long is capped by an overburden averaging about 9 feet in thickness. This overburden is loaded into cars by a steam shovel and dumped into part of the quarry which has already been worked out. The quarry is kept free from water by an electric centrifugal pump.

The rock is Niagaran dolomite. It is moderately hard, somewhat porous, especially where it is composed largely of fossil debris, gray in color, and in beds averaging 10 inches in thickness. Chert seams are common, especially toward the bottom of the exposure.

The holes for the heavy blasting are drilled by a Cyclone well drill. The entire 52 feet is blasted at one time, and the larger pieces reduced to the desired size by block holing or dobie shots. An Ingersoll-Rand steam drill and jack-hammers are used for drilling the holes for the smaller shots. The broken stone is loaded by hand into 3-ton cars, pushed to the bottom of the incline, and pulled up to the crusher by a cable.

The stone first runs through a No. 7½ Austin crusher after which it is screened. All stone over 6 inches is used for making lime. The remainder is further crushed by a No. 4 and No. 6 Austin and a No. 4 Gates, to any size desired. The screens are rotaries, two in number, with outer jackets 60 inches in diameter and 18 feet long, and with inner jackets 48 inches in diameter, and of the same length. The plant is electrically operated thoroughout by power from the Sanitary District of Chicago.

The daily production is about 1,000 yards. The bins at this plant are capable of holding 1,000 cubic yards.

The stone is used as road metal, agricultural limestone, concrete aggregate, and railroad ballast.

The stone is shipped over the Chicago and Joliet Electric Railroad.

L. No. 144

Federal Stone Company, La Grange

NW. ¼ NE. ¼ NE. ¼ sec. 10, T. 38 N., R. 12 E.

This quarry was idle for a number of years, but was reopened in 1920. The pit is roughly oval in shape, and has a 35-foot face on the upper level. A second level with a 25-foot face has been developed below the first, and a third and still lower level is included in development plans. The overburden averages about 2 feet in thickness and consists of black loam and clay. It is removed by a steam shovel and auto trucks. Three electric centrifugal pumps keep the quarry dry.

The rock is Niagaran dolomite (figs. 13 and 14), commonly a hard, fine-grained, brittle, dense, white stone, but where fossil debris is prominent. it is porous and gray.

In case of both levels the entire thickness of rock is drilled with well drills and blasted down at one time. Jack-hammers are used for drilling the holes for the block hole shots. On both levels the stone is loaded by steam shovel into quarry cars, pulled by a locomotive to the base of the incline and by cable up the latter to the crushers.

The primary crusher consists of an Allis-Chalmers No. 18, style N. The rock is first run through the crusher, then screened and distributed to the smaller crushers consisting of No. 8 McCully, No. 5 McCully, and a No. 4 Gates. There are 2 Allis-Chalmers rotary screens 20 feet by 60 and 83 inches respectively, and one 16 feet by 60 inches. The plant is capable of producing crushed stone of any size desired, and is electrically operated throughout by power from the Public Service Company. The storage equipment consists of bins capable of holding about 1200 yards. The daily capacity of the plant is almost 3,000 yards.

The stone is used as concrete aggregate, road metal, agricultural limestone and railroad ballast. It is largely consumed locally in and around Chicago.

The company has a switch to the Indiana Harbor Belt Railroad.

L. No. 145

Dolese and Shepard Crushed Stone Company, Novak

SW. ¼ sec. 15, and NW. ¼ sec. 22, T. 38 N., R. 12 E.

This quarry, located at Novak, is oval in shape, about half a mile wide and three-fourths of a mile long, with a circumference of about 1¼ miles

Fig. 13. The two levels in the quarry of the Federal Stone Company showing the method of loading on the second or lower level.

Fig. 14. Loading Niagaran dolomite from the first level of the quarry of the Federal Stone Company.

Within the larger quarry is a smaller circular one, with a diameter of about 2,000 feet. In both quarries the face of stone varies between 30 and 40 feet in height. The overburden ranges from 3 to 18 feet in thickness and averages about 10. It consists of black loam and brown clay till, and is removed by steam shovels and dump cars. The quarry is kept dry by six centrifugal pumps, two of which are in operation continuously.

The rock in the quarry is Niagaran dolomite, and is fine-grained, hard, brittle, and gray, with but a small amount of the common fossil debris.

The holes for heavy blasting are drilled with Cyclone churn drills and are spaced 10 feet apart, and 16 feet back from the face. The entire 40 feet of rock is shot down at one time. The explosives used for blasting are 40 per cent Trojan powder and 60 per cent dynamite. Jack-hammers are used in drilling the holes for the smaller shots. The broken rock is loaded by steam shovels into 12-yard quarry cars which are electrically operated, each equipped with two 30 horse power motors and controlled by an operator in a tower near the crushing plant. The control of the cars is effected by having separate switches for each 40 feet of track. The cars always travel in the same direction, making a complete trip around the circuit of the quarry for each load of stone.

The cars coming from the quarry dump sideways into a No. 42 Power and Mining Company crusher from which the stone is conveyed by a rubber belt 660 feet long to a second crushing unit. Here the rock is screened, crushed again and conveyed on another belt of the same size to a third crushing unit where the process of screening and crushing is again repeated. The secondary crushers consist of a No. 9 Power and Mining Company, a No. 9 Allis-Chalmers, and a No. 6 and a No. 4 Allis-Chalmers. Two Power and Mining Company rolls are used in the production of lime dust. The broken rock is sorted by 4 cylindrical screens, 48 inches by 30 feet and four shaker screens. The screens are of Power and Mining and Allis-Chalmers make. All machinery is electrically operated by power manufactured by the company.

From the crushing units the sorted stone is transferred to ten cylindrical concrete bins, having a total capacity of 100 carloads. The daily production is about 3,000 tons; the yearly production about 1,000,000 tons. The capacity of the plant is 5,000 tons.

The stone is used as concrete aggregate, agricultural limestone, railroad ballast, road metal, and as a flux.

The company has a switch to Hawthorne, where connection is made with the Santa Fe, Elgin, Joliet and Eastern, and Indiana Harbor Belt railroads.

L. No. 146

Superior Stone Company, La Grange

SW. ¼ NE. ¼ NE. ¼ sec. 10, T. 38 N., R. 12 E.

The quarry operated at La Grange is circular in shape with a diameter of about 500 feet. The face of the rock is 60 feet high and is capped with an overburden about 4 feet in thickness. The latter is a black loam and gravel mixed with sandy clay. The quarry is drained by two centrifugal electric pumps.

The rock is the Niagaran dolomite. It is moderately hard, crystalline, somewhat porous, blue-gray in color, with rather large amounts of fossil debris.

The rock is drilled with a Cyclone well drill and the entire face blasted at one time. The holes for the smaller shots are drilled by jack-hammers. The rock is loaded by steam shovel into 3-ton quarry cars, pulled by horse to the base of the incline and up the latter by cable.

The rock is first run through an Allis-Chalmers No. 18 crusher, and then screened and diverted into a No. 8 and two No. 5s of the same make. One pulverizer is in operation for the manufacture of lime dust. The broken stone is sorted by two rotary screens 48 inches by 24 feet, and two shakers 6 by 10 feet. The plant is operated by electricity obtained from the Sanitary District of Chicago.

The daily production is about 1,000 yards. The bins of this plant have a capacity of 600 tons.

The stone is used as road metal, aggregate, agricultural limestone, and railroad ballast.

The company has a switch to the Indiana Harbor Belt Railroad and does a considerable amount of shipping for short distances by truck.

L. No. 147

NE. 1/4 SE. 1/4 sec. 29, T. 39 N., R. 14 E.

Stearns Lime and Stone Company

Twenty-ninth and Halsted Streets, Chicago

This quarry is circular in outline, and is about 500 feet in diameter. It has been in operation for a long time and as further lateral expansion is impossible, working is confined to deepening the quarry. A thickness of 200 feet of stone is exposed but only the lower 12 of this is being worked. The quarry is being deepened in 12-foot benches. A Frahm steam pump keeps the quarry free from water.

The stone in the quarry is the Niagaran dolomite and is moderately hard, somewhat porous, gray, fairly tough, and is found in thick beds.

The holes for the heavy blasting are drilled with an Ingersoll-Rand drill and the smaller ones for the block hole shots by jack-hammers. The 12-foot face is blasted with 40 per cent dynamite. The stone is loaded into 2-ton quarry cars and pulled to the foot of the incline by horses, and up the latter by cable.

The rock from the quarry is screened and all over 6 inches is used for the manufacture of lime. The chunks of smaller size are crushed to any desired size up to 2 inches, by a No. 5 and a No. 3 Gates crusher. The rock is sorted by four screens 36 inches by 10 feet. The plant is operated by steam throughout.

The daily production is about 100 yards, which represents about one-half capacity. The bins of this company can hold 300 yards of crushed stone.

The stone is used for the manufacture of lime as concrete aggregate and road metal. The stone is sold locally, and is transported by truck.

L. No. 148

Chicago Union Lime Works

Sec. 19, T. 39 N., R. 14 E.

Nineteenth St. and Lincoln Ave., Chicago

This quarry is circular in shape, with a diameter of about 550 feet. It is a very old quarry, and has reached its maximum lateral extension, so that rock can be obtained at present only by deepening. The opening is already 350 feet deep, and is being worked deeper in 20-foot benches. The quarry is kept dry by Allis-Chalmers pumps, which discharge the water into the city sewer.

The quarry is in the Niagaran dolomite. The dense, gray, moderately hard dolomite is composed of beds only 3 to 10 inches thick which are separated along the bedding planes by thin layers of greenish clay.

Certain portions of the rock in the quarry are better fitted for the manufacture of lime than others. The stone to be burned for lime is loaded by hand into small cars which are lifted directly to the kilns by a crane with a long cable. The stone to be crushed for other purposes is loaded by a steam shovel into 2-yard cars, pulled to the hoist by a gasoline locomotive and elevated to the crusher by an Allis-Chalmers double drum hoist.

The primary crusher is a Traylor, with a jaw 28 by 36 inches. The rock is fed into it by a metal belt and having received its first crushing is transferred by bucket-belt elevators to the screens. From the screens it goes to two No. 3 McCully crushers, and to two sets of Power and Mining Company rolls in case a finer product is desired. Two screens are in use, both 60 inches by 25 feet.

The capacity of this plant is 500 yards daily and it can be kept in operation for the entire year. The limit of deepening the quarry is said to be 500 feet. In that case the company still has a reserve of 150 feet of rock. The bins at this plant have a storage capacity of 5,000 yards.

The stone is used for the manufacture of lime and as road metal, concrete aggregate, and agricultural limestone. It is sold locally, and is transported by wagon or motor truck.

L. No. 151

A. C. O'Laughlin Stone Company, Bellewood

SE. 1/4 NW. 1/4 SE. 1/4 sec. 8, T. 39 N., R. 12 E.

This quarry is circular in outline and about 1000 feet in diameter. The face being worked is 105 feet high, and has a clay overburden which averages 5 feet in thickness. The quarry is drained by centrifugal electric pumps.

The stone is the Niagaran dolomite, and is dense, fine-grained, finely crystalline, white, with thin layers of green clay along the bedding planes.

A well drill is used to make the deep holes, and after the entire face has been blasted down with 40 per cent dynamite the large pieces are further reduced in size by block holing. The stone is loaded by steam shovel into 6-yard cars and pulled by a locomotive to the incline from where it is pulled up to the primary crusher by cable.

The rock first passes through a No. 18 Allis-Chalmers then through a screen and finally to five other smaller crushers of sizes No. 5 to No. 8 which reduce it to the desired size. Some of the stone is dried and run through Allis-Chalmers ball mills which reduce it to a size usable for agricultural or ground limestone. Two ball mills are in operation. The entire plant is electrically operated.

The daily production of this quarry is about 2,400 yards; the yearly production about 400,000 tons.

The stone is used as concrete aggregate, road metal, railroad ballast, ground limestone, and agricultural limestone.

The company has switching facilities to the Illinois Central, and Chicago Great Western railroads.

The Waste Pile Along the Desplaines Drainage Canal

In deepening Desplaines River or straightening its channel so as to make the Drainage Canal, it was necessary to do a great deal of excavating in some places. In general at least a portion of this excavation was made in the underlying Niagaran dolomite, and this stone has been piled up on each side of the canal in a long ridge varying from 10 to 50 feet in height. This spoil bank offers a supply of good stone easily obtainable, which has been and is being crushed and made use of, near Lemont, by the Great Lakes Dredge and Dock Company, and by the Lincoln Park Commission of Chicago. In both cases the rock is loaded into skips and transferred to barges which are towed to their destination. The stone is used for filling cribs and breakwaters at Chicago.

Western Stone Company, Lemont

SE. ¼ SW. ¼ NE. ¼ sec. 19, T. 37 N., R. 11 E.

On the north side of the Desplaines Drainage Canal there is an abandoned plant at one time used by the Western Stone Company for crushing the rock in the spoil bank along the canal. The stone was put into skips and these were loaded, two high, on the barges which were pulled to Chicago by a steam tug. The equipment on the premises is as follows:

9 barges
1 steam tug
One Allis-Chalmers crusher No. 3, two No. 4, and one each of Nos. 5, 6, and 7
23 sections of screen
Two Kehm and Metz boilers
16 smaller boilers
Miscellaneous small equipment

There is another similar plant on the south side of the canal which evidently served the same purpose. It is much more nearly dismantled than is the one described above.

QUARRY SITES

All of the best locations are occupied by quarries at the present time. There are, however, a few abandoned sites, and possible new sites that warrant discussion.

L. 140C

Stony Island

Stony Island is a small mound shaped like a figure 8, lying south of 91st Street, and east of Stony Island Avenue, Chicago. The entire hill is underlain by Niagaran dolomite with a surficial covering not exceeding 15 feet, and possibly less than two feet in some places. The rock is a dense, white, coarsely crystalline, moderately hard dolomite, and contains a large amount of bituminous material in cavities. The bituminous material is a thick tarry substance, and might necessitate special treatment of the rock during the crushing process.

This "island" has already been the site of two quarries, now abandoned, and there still remains an area about one-fourth of a mile square which has not as yet been subdivided into city lots, and would therefore be available for quarrying. About 1,000,000 cubic yards of stone would be available, if the quarry were worked to a depth of 30 feet.

The Chicago, Rock Island and Pacific, and the Indiana Harbor Belt railroads, approximately 800 feet to the south of this site, could furnish transportation.

L. No. 140

SE ¼ sec. 17, T. 37 N., R. 11 E.

At this place a bluff about 3,000 feet long exposes 45 feet of thin-bedded, fine-grained, buff-colored, Niagaran dolomite. Along the edge of the bluff, for a distance of about 50 feet back from the rock face, there is less than 10 feet of overburden and small gullies have cut down to the rock in places. The stone rises in the hills away from the bluff but the overburden also increases in thickness to at least 25 feet. In the 50-foot strip, about 225,000 cubic yards of stone is available with less than 10 feet of overburden. Some old building stone quarries were once in operation at this place, and the grading has been done for the necessary switch to the Santa Fe Railroad, a quarter of a mile to the south.

L. No. 140A

About half a mile east of the Sag bridge, on both sides of the Calumet Feeder Canal there are outcrops of hard, dense, white, fine-grained Niagaran dolomite, in most places covered by only a few feet of surficial material. The stone has been quarried in many places for building stone. An outcrop of this dolomite was noted along the road on the south side of the canal, and it is probable that the greater part of the hill is underlain by this stone. Transportation is possible by means of the Chicago and Alton Railroad, by barge on the Drainage Canal, and by truck over good roads.

L. No. 140B

Along the east bank of the Desplaines River Drainage Canal, for about 3 miles north of the south line of the county, the rock lies within a few feet of the surface. It is in this flat that the Illinois Stone Company has its quarry, and it is probable that additional favorable sites could be found in this territory. Transportation is obtainable by means of the Chicago and Alton Railroad, the Chicago and Joliet Electric, and by barge on the canal. Concrete roads are now being built in this region and will afford truck routes to Chicago, Joliet, and other towns.

The spoil banks of the Main Drainage Canal and of the Calumet Feeder as a source of stone

The spoil banks are found on both sides of both canals for nearly their entire length. They are composed of earth and rock removed in digging the canals. Where the canals were cut through rock, which did not have a heavy surficial covering, these piles afford an excellent source of stone. In many places, however, clay and glacial boulders are in predominance, in which case the pile does not offer favorable opportunities for a supply of road metal. The spoil banks of the main Drainage Canal.

which are composed chiefly of stone, extend from the vicinity of Lockport, Will County, Northward into Cook County to a point about 800 feet north of the Willow Springs bridge. In some places deposits lie on both sides of the canal, but most commonly they are found on the west side only. South of Lemont, the waste pile does not show objectionable amounts of clay or soil.

Along the Calumet Feeder, stone is abundant in the spoil banks from Blue Island west to the Sag, and west to the junction of the Feeder and the main canal. The bed rock at Blue Island is covered by glacial drift, and the waste pile, therefore, consists largely of that material. This is true to a greater or less extent for the pile along the entire length of the Feeder, except for the stretch about 1½ miles long between the Sag bridge and the main canal, where the pile is largely rock and might provide a good supply of stone. Sample L. No. 137 was taken from the pile in the NW. cor. NW. ¼ sec. 21, T. 37 N., R. 12 E.

DE KALB COUNTY

A covering of glacial drift obscures the underlying rock of De Kalb County (fig. 21, p. 125) except in a few places along the major streams. The most important outcrops reported are as follows:[1]

In sec. 2, T. 42 N., R. 4 E., a small quarry in Galena dolomite may be found.

Near the middle of the dividing line between secs. 17 and 18, T. 42 N., R. 4 E., two small quarries expose 5 feet of yellowish (locally reddish) porous limestone, composed largely of fragmentary organic remains. The limestone probably belongs to the Alexandrian series.

Near the cen. W. ½ of sec. 30, T. 42 N., R. 3 E., about 10 feet of thin-bedded, buff, porous fossiliferous limestone, probably of Galena age outcrops in a small ravine along the road.

DUPAGE COUNTY

Although Dupage County (fig. 9, p. 98) is underlain by Niagaran dolomite, so deeply does the drift bury it, that, with one exception, no areas of more than several acres with less than 10 feet of overburden occur near any of the railroad lines. In one or two localities, however, rock may be obtained in quantity.

SHIPPING QUARRY

L. No. 150

Elmhurst-Chicago Stone Company, Elmhurst

SW. ¼ NW. ¼ sec. 2, T. 39 N., R. 11 E.

Due to the flatness of the surrounding country the Elmhurst quarry is worked as a pit. It is oval in outline and has a maximum width of about

[1] Bannister, Henry M., Geology of DeKalb, Kane and Du Page counties: Geological Survey of Illinois, vol. IV, p. 122, 1870.

950 feet, and a minimum of 800 feet. The quarry is kept dry by two centrifugal pumps.

The overburden is of clay till which ranges from 5 to 20 feet in thickness but averages about 12 feet. The overburden is removed by clam-shell cranes, and some of it is used by the Chicago and Northwestern Railroad for making fills.

Seventy feet of Niagaran dolomite is quarried. The upper 30 feet is brown, medium-grained, and porous dolomite, in beds 6 inches to 3 feet thick. The lower 40 feet is fine-grained, white dolomite, in layers 4 to 14 inches thick. Chert as thin layers and nodules is common in the lower 40 feet.

A face of rock 70 feet high is worked. The holes are drilled with a clipper electric drill and the full thickness is blasted down at one time with 40 per cent Trojan powder.

The broken rock is loaded by steam shovels into 6-ton quarry cars which are hauled to the tipple by a gasoline locomotive. The cars are drawn up the tipple to the primary crusher by cable.

The crushing plant consists of a primary crusher (a No. 36 McCully-Superior) and of two secondary crushing and screening units. After the rock has passed through the large crusher it is carried by conveyor belts to one or both of the smaller units for final crushing and screening. The first of the secondary crushing units contains a McCully No. 7½, and two McCully No. 5 crushers, while the other contains three McCully crushers, a No. 7½, a No. 6, and a No. 4.

Worthington rotary screens are employed in both units, the first unit contains two 48-inch screens, one 20 feet long and one 16 feet long, and the second unit, two 48-inch screens, one of which is a double screen. By changing sections of screening, rock of any size up to 5 inches or even larger, can be obtained. The daily capacity of each unit is about 1,000 yards. The total daily production is about 1,000 tons per day and the yearly production about 250,000 tons. Bins of 650 tons capacity are used for storage purposes.

The product is used for railroad ballast, road material, concrete aggregate, and agricultural limestone. The company also manufactures concrete blocks.

Transportation is provided by the Chicago and Northwestern Railroad.

OUTCROPS MAINLY OF LOCAL IMPORTANCE

SW. ¼ sec. 24, T. 39 N., R. 11 E.

Six feet of fine-grained, light-gray, Niagaran dolomite outcrops in an old abandoned quarry in the SE. ¼ SW. ¼ sec. 24, T. 39 N., R. 11 E. The rock occurs in beds from 1 inch to 6 inches thick, and probably continues in depth for more than 100 feet.

The surrounding topography is almost flat, and it is probable that as much as 25 acres is underlain by rock at depths of less than 5 feet.

The nearest railroad, the Chicago and Northwestern, is about 3 miles north of this locality.

L. No. 166

About 5 feet of coarse-grained, crystalline limestone is exposed in an old abandoned quarry about 1¼ miles south of Naperville, in the NE. ¼ NW. ¼ sec. 30, T. 38 N., R. 10 E. The country is gently rolling. About 8 acres is available with less than 10 feet of overburden. Other outcrops of similar rock are found at places along Dupage River in this vicinity.

GRUNDY COUNTY

Rock for use as road material can be obtained only in the small area in the northeastern part of the county (fig. 21, p. 125), where the Galena-Platteville dolomite and the Maquoketa limestone comprise the bed rock. The remainder of the county is underlain by the shales and sandstones of Pennsylvanian age.

SHIPPING QUARRIES

No rock is being quarried within the county at the present time, but both the Galena dolomite and Maquoketa limestone outcrop, or are known to be very close to the surface at several places. Outcrops of the Galena-Platteville are found along Collins Run in the east-central part of sec. 18, T. 34 N., R. 8 E., in an old abandoned quarry near the center of sec. 24, T. 34 N., R. 7 E., and along Aux Sable Creek near the cen. sec. 19, T. 34 N., R. 8 E. At none of these outcrops is the overburden over 5 feet, and it is probable that rock may be found at depths of less than 8 feet throughout the area containing these outcrops.

POSSIBLE SHIPPING QUARRY SITES

L. No. 175

Exploration may reveal a considerable area in the N. ½ sec. 19 or the SW. ¼ sec. 20, T. 34 N., R. 8 E. within half a mile of the Chicago, Rock Island and Pacific Railroad, where large quantities of rock may be obtained by removing less than 10 feet of overburden.

The rock is Galena-Platteville and where exposed is a dense, buff dolomite in beds not over 12 inches thick. The greatest thickness exposed is about 5 feet, but the rock is reported to continue in depth for more than 150 feet.

L. No. 176

Outcrops of Maquoketa limestone occur at several places in the north central and southeast part of T. 34 N., R. 8 E. The overburden is not more than 5 feet thick at any of the exposures and as some of the outcrops are found in the higher elevations it is probable that most of secs. 25, 26, 27, 34, and 35, T. 34 N., R. 8 E. are underlain by Maquoketa limestone with no great thickness of overburden.

The rock is a mottled pink and white, coarsely granular, crystalline limestone in beds ranging from 4 to 12 inches in thickness. The greatest thickness observed was 12 feet, but the rock may reach a thickness of approximately 60 feet before the underlying shaly phase of the Maquoketa is reached.

The Elgin, Joliet and Eastern Railroad crosses this area near the center of secs. 27 and 34, and could provide shipping facilities should a quarry be opened here.

JO DAVIESS COUNTY

TOPOGRAPHIC RELATIONS

Jo Daviess County (fig. 15) exhibits by far the roughest topography in northern Illinois. Unlike the other counties of that portion of the State, it has not been glaciated, except in the eastern part, so that stream erosion has dissected the region to a stage of maturity. The obscuring effect of the glacial drift, however, is in a measure supplanted by a covering of a fine, buff-colored earth known as loess. The loess reaches its maximum thickness on top of the bluff along Mississippi River, where 30 to 40 feet of it may be observed. It thins rapidly to the east, however, and at several locations two or three miles east of the river bluff has a thickness of only 8 or 12 feet.

THE ROCK FORMATIONS

Platteville limestone.—The Platteville limestone outcrops at but one place in the county, namely, along Galena River. The character of the outcrop makes quarrying unfeasible.

Galena dolomite.—The Galena dolomite is the most important source of road material in the county. It consists of a crystalline, coarse-grained, porous rock, gray when fresh, and buff when weathered. The beds range from one to four feet in average thickness, but particularly in the upper and lower parts of the formation, thinner beds are not at all uncommon (fig. 16). The medial portion of this formation contains chert as bands or as disseminated masses (figs. 17 and 18).

Maquoketa formation.—The Maquoketa formation consists of interbedded limestone and shale, the latter constituting about 80 per cent of the total thickness. It is unimportant as a source of any great amount of road material.

The Niagaran dolomite.—The Niagaran dolomite forms the cap of most of the hills particularly in the southwest and central portions of Jo Daviess County. There are apparently two divisions of the Niagaran:—the lower, which is thin-bedded, cherty, buff-colored and highly argillaceous; and the upper, which contains beds 5 to 10 feet thick, is moderately hard, coarse-grained, and generally free from chert.

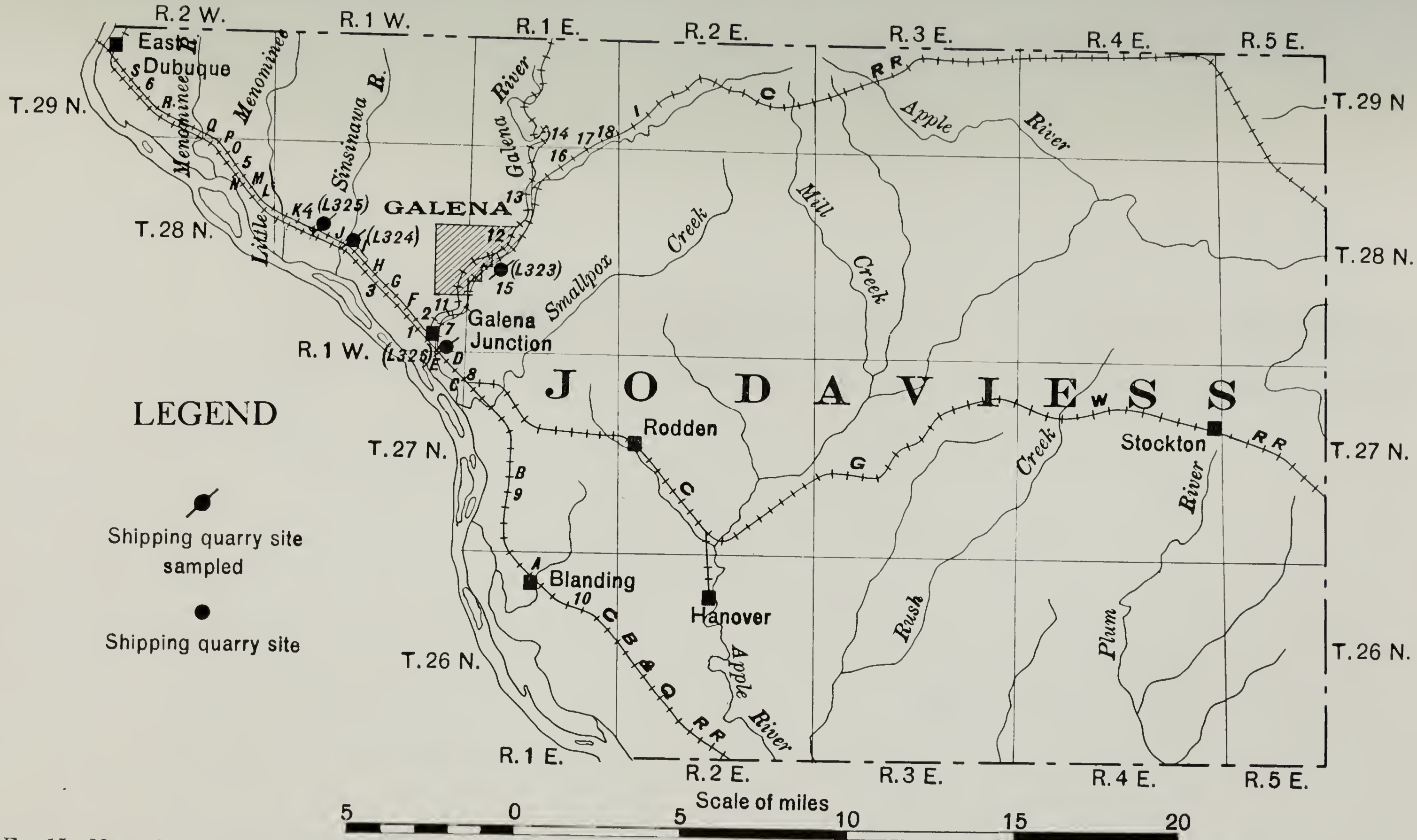

FIG. 15. Map of Jo Daviess County showing location of quarry sites. Small italicized figures not enclosed in parenthesis refer to parts of bluff described in the text. Small italicized letters refer to cross sections in figure 19.

FIG. 16. Upper thin beds of the Galena dolomite in a quarry one and a third miles north of the hotel at Hanover.

FIG. 17. Typical section of the massive non-cherty and massive cherty member of the Galena dolomite on Galena River at Millville.

SHIPPING QUARRIES

There are no quarries shipping crushed stone in this county.

SITES FOR SHIPPING QUARRIES

L. Nos. 324, 325 and 326

The bluff of Mississippi River north of Galena Junction

The search for shipping quarry sites in this county was confined primarily to the territory adjoining the railroads. The following discussion treats with the more important sites. There is, however, possibility of obtaining stone at other places, but to a lesser advantage than at those par-

FIG. 18. Thin bedded Galena dolomite on Sinsinawa Creek at the bridge in sec. 4, T. 28 N., R. 1 W. (Rawlins Twp.).

ticularly mentioned in this report. The numbers given to the various unit areas in the following text correspond with those on the map of Jo Daviess County.

1. North from Galena Junction the bluff is composed of characteristic Galena dolomite (fig. 18). The lower 20 to 30 feet of the bluff is hidden by an accumulation of talus, above which rises a sheer face of stone for about 75 feet, overlain by loess, which gradually increases to a thickness of from 10 to 25 feet back from the immediate face of the bluff.

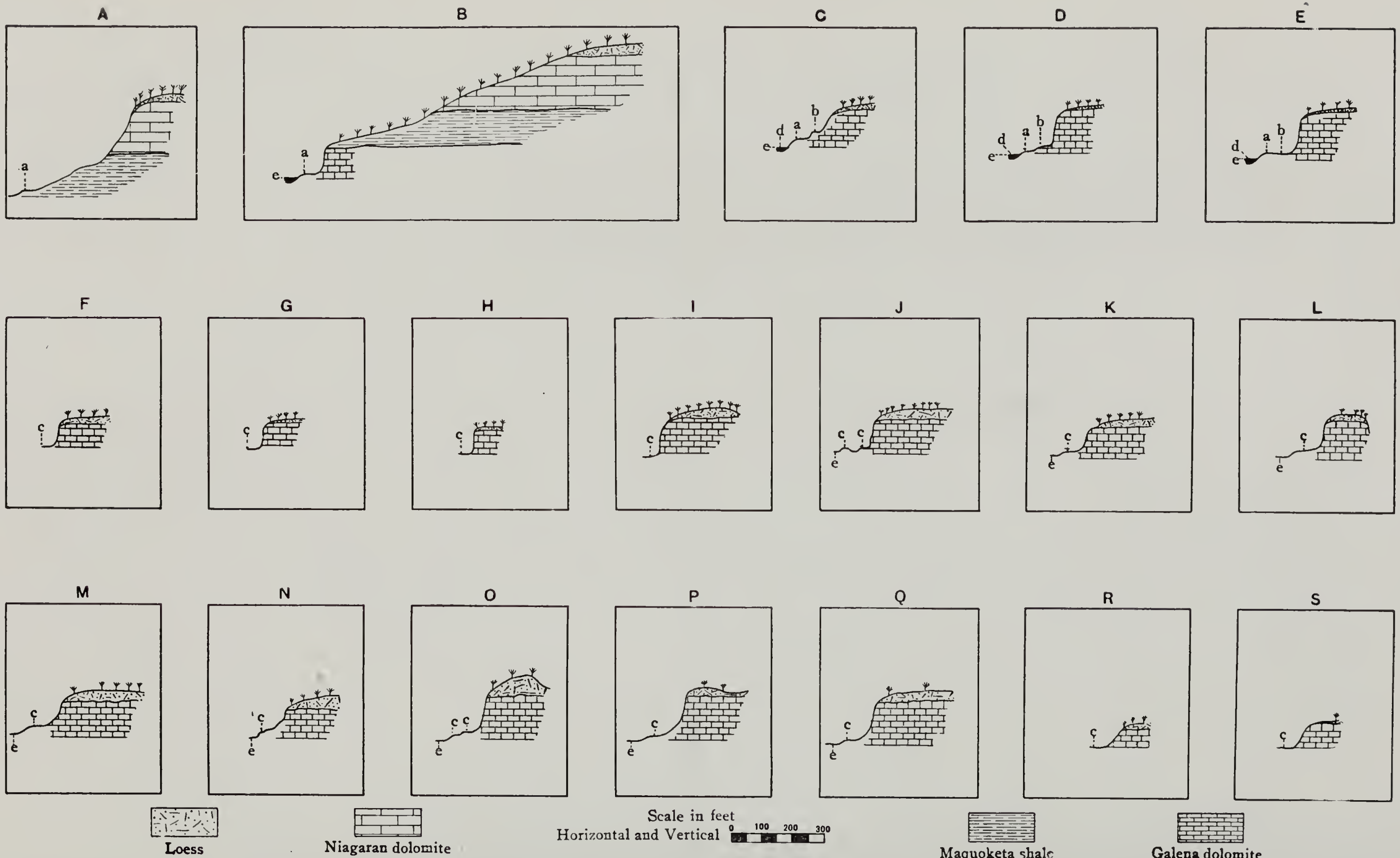

FIG. 19. Diagrammatic cross sections of the Mississippi river bluff from Blanding, northwest to the county line. Locations of sections are indicated on map of Jo Daviess County (fig. 15).

a. Chicago, Burlington and Quincy Railroad. b. Chicago and Great Western Railroad. c. Illinois Central Railroad. d. Harris slough. e. River level.

2. The bluff maintains this character for about half the distance between Galena Junction and Gears Ferry, in the SW. cor. sec. 35, T. 28 N., R. 1 W. For the remainder of the distance the bluff is lower and more irregular, the talus accumulation at its base greater, and the loess covering more obscuring.

3. North from Gears Ferry to Sinsinawa River, the bluff is rather low and irregular and exhibits about the same general relations as discussed in unit 2, except that the loess overburden is generally greater and that the bluff is more markedly dissected by fair-sized valleys.

4. From Sinsinawa River north to the Little Menominee River the bluff again assumes an appearance similar to that at unit 1. In places it stands with a bold face 40 to 60 feet high, and then rises rapidly as a steep but irregular slope for 30 to 50 feet, composed of large fragments of rock and is partly overgrown with vegetation. The overburden is in general from 10 to 20 feet in thickness.

5. From Little Menominee River north to the Menominee River, the bluff partakes of the characters of all the preceding portions. In general, however, the bluff is highest in secs. 18, T. 28 N., R. 1 W., 12 and 13, T. 28 N., R. 2 W. and gradually lowers toward Menominee River. In sec. 2, T. 28 N., R. 2 W. it is not generally attractive for quarrying.

6. From Menominee River north to the county line the bluff is low considerable distance back from the railroad and of no great importance for quarrying.

THE BEST QUARRY SITES

The Illinois Central, Chicago and Northwestern, Chicago Great Western, and Chicago, Burlington and Quincy railroads use jointly the right of way which runs along the bottom of the bluff from Galena Junction as far north as Menominee River. Any site selected in this portion of the bluff would therefore have the desired transportation if a switch could be installed. Almost all portions of the bluff would furnish quarry sites, but the most favorable ones, that is, with the least overburden and the greatest thickness of rock, are to be found in parts numbered 1 and 4 with possibilities in unit 5.

Sample L. No. 325 represents the rock in sec. 17, T. 28 N., R. 1 W. in part 4 of the bluff and L. No. 324 in sec. 21, T. 28 N., R. 1 W. in part 3 of the bluff.

Mississippi River bluff south of Galena Junction

7. By far the best site for a shipping quarry to be found anywhere along the bluff is located on the inside of the bend where the Chicago, Burlington and Quincy turns up the valley of the Galena River (fig. 19D).

The bluff at this place has an almost sheer face for approximately 60 to 80 feet above the railroad, a total height of 110 to 130 feet, and is overlain by a thin overburden, probably less than 12 feet on the average. The rock is of good quality and sample L. No. 326 represents it as closely as was obtainable. Further, the site is in such a location as to permit the use of the switching facilities offered at the railroad junction so as to ship on the Illinois Central, Chicago, Burlington and Quincy, Chicago Great Western, and Chicago Northwestern. The quantity of rock available is immense and labor could undoubtedly be obtained from Galena about three miles to the northeast.

8. About a quarter of a mile south of the bend in the railroad the bluff loses the characteristics described above and gradually lowers in

Fig. 20. The Mississippi River bluffs at Galena Junction.

height until it vanishes almost completely in secs. 8, 9 and 16, T. 27 N., R. 1 E. north and south of Aiken.

9. From the north line of sec. 21, T. 27 N., R. 1 E. south to Blanding the bluff consists of Galena dolomite overlain by Maquoketa shale, which is in turn overlain by Niagaran dolomite. The Galena is not visible in the bluff for the entire distance but occurs in the bottoms and sides of the small valleys which have cut down through the bluff. In sec. 21, in general, the respective thicknesses of the three formations in ascending order are about 100, 100, and 180 feet, with a capping of loess 15 to 30 feet thick. In sec. 33, T. 27 N., R. 1 E. the Galena dolomite is not exposed but 140 feet of Maquoketa and 170 feet of Niagaran dolomite can be seen. The Chicago, Burlington and Quincy Railroad runs along the bottom of the bluff and

if a quarry in the Niagaran dolomite 140 to 200 feet above the railroad were desired, this site would offer abundant opportunities for such a quarry.

10. South of Blanding the railroad recedes from the bluff, which lowers and becomes obscured by talus so that only portions of the capping Niagaran dolomite are visible.

From Galena Junction north along Galena River

11. In general the banks of Galena River between Galena Junction (fig. 20) and Galena do not show any particularly favorable quarry sites. Perhaps the best one is to be found on the west side of the stream about three-quarters of a mile north of the Junction, where about 100 feet of Galena dolomite is available in the bluff along the river. The overburden is thin, but because the site is served only by the Chicago and Northwestern Railroad, and because it is so close to the bluff of the Mississippi with its better sites, this location is probably of minor interest.

North from Galena along the river, the following sites are available along the Chicago and Northwestern Railroad.

12. In the center of sec. 16, T. 28 N., R. 1 E. on the north side of the railroad there is a bluff of Galena dolomite, the lower part of which is obscured. The total thickness of rock available is about 100 feet and is overlain by less than 20 feet of overburden.

13. In the NW. ¼ sec. 10, T. 28 N., R. 1 E. on the west side of the railroad, the bluff is covered to a great extent but contains about 200 feet of Galena dolomite, with an overburden of 20 to 40 feet of Maquoketa shale. By proper selection of a quarry site, however, a great part of this overburden could be avoided and a large quantity of rock with a small overburden be obtained.

14. In the center of the W. ½ sec. 34, T. 29 N., R. 1 E. on the south side of the railroad and in the NW. ¼ on the east side of the railroad, there is a bluff of Galena dolomite about 130 feet high, with a relatively small amount of overburden, which might afford possible sites for shipping quarries.

L. No. 323

15. In the NW. ¼ NW. ¼ sec. 21, T. 28 N., R. 1 E. on the south side of Galena River there is a rock hill about 1100 feet long. A quarry along the road on the south side of the hill exposes the Galena dolomite, which also shows in the road. The soil on the hill is thin and could easily be removed if quarrying were to be carried on. Sample L No. 323 represents the less weathered layers in the small quarry.

Along the Illinois Central Railroad northeast from Galena, the following are the better sites encountered.

16. In the NE. ¼ NW. ¼ sec. 2, T. 28 N., R. 1 E. there is a very precipitous bluff of Galena dolomite about 180 feet high, and with a relatively slight overburden.

17. In the SW. ¼ sec. 35, T. 29 N., R. 1 E. a similar bluff is to be found.

18. In the center of the SW. ¼ sec. 36, T. 29 N., R. 1 E. is a bluff about 120 feet high, composed of Galena dolomite, with a relatively small amount of overburden.

LOCAL QUARRIES

Stone has been quarried to a small extent at Galena and at Stockton. At the former place the Galena dolomite was quarried and at Stockton the limestone member of the Maquoketa.

LOCAL QUARRY SITES

Because of the general roughness of the topography and proximity of the rock to the surface, outcrops of stone suitable for use on local road construction are available in very great number throughout the county. These outcrops usually occur in the tops of hills or along creeks. In general the rock which caps a hill with a gentle slope is Niagaran dolomite and that occurring along the streams and in the bottom of the valleys is the Galena dolomite.

KANE COUNTY

The Galena and Niagaran dolomite constitute a large portion of the bed rock of Kane County (fig. 21). They are, however, nearly everywhere so deeply buried beneath a cover of glacial drift as to be unavailable for use as road material.

The Galena dolomite, which underlies most of the western half of the county, presents no outcrops worthy of consideration as sources for road material.

The Niagaran dolomite, which underlies most of the east half of the county, is well exposed only along Fox River south of Elgin. The exposures are limited to the immediate vicinity of the river bank and as there are roads on both sides of the river a short distance from the banks, the area of available stone is not large.

SHIPPING QUARRIES

No shipping quarries are located in the county, but rock for local use has been quarried at several places. None of the outcrops examined appears to offer any great opportunities for development of shipping quarries, but some of them may be of local importance.

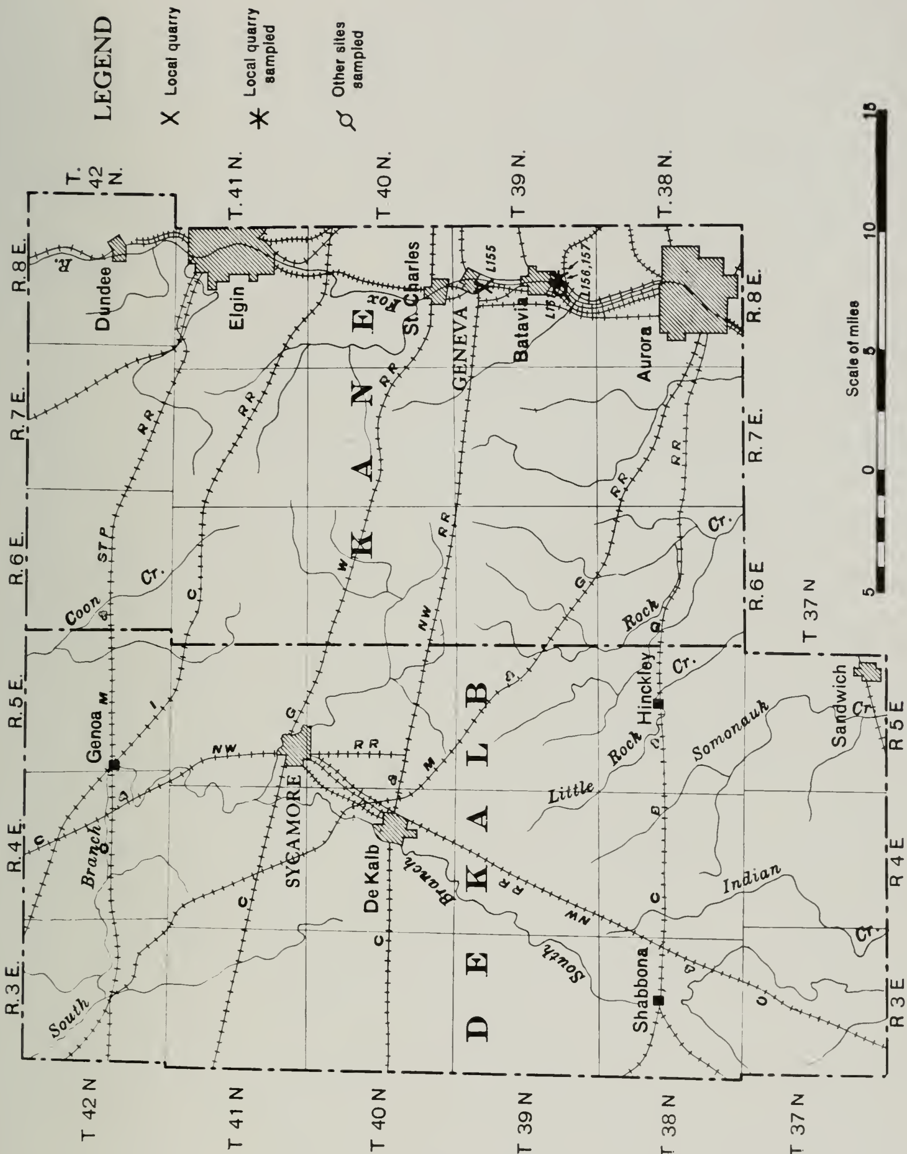

FIG. 21. Map of Kane and DeKalb counties, showing location of quarries and sites sampled.

LOCAL QUARRIES

L. Nos. 156 and 157

Hendrickson's quarry

Rock for use on local roads has been quarried about a mile south of Batavia on the east bluff of Fox River in the SE. ¼ NE. ¼ sec. 27, T. 39 N., R. 8 E. The quarry is about 300 feet long and has been worked back into the bluff for 100 feet. The quarry face is 25 feet high.

The overburden consists mainly of gravel with some sand, and ranges in thickness from about 15 to 35 feet, with an average of about 25 feet. Much of the gravel overburden is used directly as road material, but because of its coarseness it is necessary to crush the gravel from the lower 10 feet of the overburden to fit it for the same purpose.

The underlying dolomite is of Niagaran age and the following section is exposed.

	Thickness *Feet*
2. Dolomite, compact, gray-white, in beds 6 to 10 inches, with layers and nodules of chert	8
1. Dolomite like above but free from chert and in beds 1 to 3 feet	17

The Chicago, Burlington and Quincy Railroad runs on top of the bluff just east of the quarry, so that further development in that direction is prevented. However, as much of the gravel along the bluff has already been removed, there is available a strip about 50 feet wide and 1,000 feet long with little or no overburden, and if about 10 to 15 feet of overburden were removed a total width of about 100 feet of rock would be made available.

At present the rock is quarried by prying loose blocks of stone and loading them on wheelbarrows and wheeling them to a No. 5 Austin crusher. A 36-inch screen is used to separate the crushed rock into desired sizes. The daily production when the quarry is being worked amounts to about 125 yards. The capacity of the plant is 300 yards.

No shipping facilities are at present available, but it is planned to elevate the rock to bins on a level with the Chicago, Burlington and Quincy Railroad.

Sample L. No. 156 is from a lower rock ledge near the quarry and L. No. 157 from the quarry face.

L. No. 155

Riverbank Stone and Lime Quarries Company

The Riverbank Stone and Lime Quarries Company have operated a small quarry along the west bank of Fox River about half a mile south of Geneva, in the cen. S. ½ of sec. 10, T. 39 N., R. 8 E.

The rock is a fine-grained, buff dolomite in beds 1 to 3 inches thick. It is Niagaran in age.

The quarry is about 500 feet long and has been worked back about 250 feet. The greatest thickness of rock exposed is 12 feet. The quarry was not in operation at the time of investigation so that no data are at hand regarding methods of operation. An Aurora Rock crusher No. 1 is used in crushing the rock.

The amount of rock still available at this place is probably not great. The quarry has been worked back to the road so that no great extension in that direction is possible; lateral expansion parallel to the river is not feasible because the amount of rock above the water decreases abruptly on each side of the present quarry; and downward expansion is impracticable because the quarry would be subject to flooding in high water and even in normal times the amount of water due to seepage would probably be excessive.

L. No. 161

On the west side of Fox River about half a mile south of Batavia in the NE. ¼ NW. ¼ sec. 27, T. 39 N., R. 8 E., there is exposed along the foot of the bluff about 13 feet of fine-grained, white to buff Niagaran dolomite in beds 4 to 10 inches thick. The exposure is about 2,000 feet long and is capped by about 25 feet of sandy, clay till. The overburden rises sharply from the edge of the rock but a strip about 50 feet wide is available with less than 10 feet of overburden. Rock for local use has been quarried here.

The Chicago and Northwestern Railway runs along the foot of the bluff.

LOCAL QUARRY SITES

NE. ¼ sec. 15, T. 39 N., R. 8 E.

About 22 feet of Niagaran dolomite outcrops at the foot of the bluff along the east bank of Fox River about half a mile north of Batavia in the SW. ¼, NE. ¼ sec. 15, T. 39 N., R. 8 E.

The exposure is about 1,500 feet long and is covered by about 18 feet of gravelly till. Only the rock along the lower part of the bluff would be available for quarrying, for a road running parallel to the river is located at the top of the bluff and is flanked by dwellings.

The rock is a fine-grained, buff to gray dolomite in beds 1 to 6 inches thick. A width of about 200 to 300 feet of rock, having an average thickness of about 15 feet, is available with less than 10 feet of overburden.

A branch of the Chicago and Northwestern Railway runs on an 8-foot embankment at the foot of the slope.

SW. ¼ sec. 3, T. 40 N., R. 8 E.

About 18 feet of finely crystalline Niagaran dolomite is exposed along the west bank of Fox River about 4 miles north of St. Charles in the SW. ¼ SW. ¼ sec. 3, T. 40 N., R. 8 E.

The exposure is about 2,500 feet long and lies between the St. Charles road and the river. A strip not more than 75 feet wide is available for quarrying here. Some rock does outcrop west of the road but the rapid thickening of the overburden prohibits its utilization. It is probable that small amounts of rock for local use may be obtained here.

SW. ¼ sec. 33, T. 38 N., R. 8 E.

Finely crystalline, cherty, buff-colored Niagaran dolomite, 11 feet thick, outcrops in the east bank of Fox River just south of Aurora in the SW. ¼ sec. 33, T. 38 N., R. 8 E. An area about 400 feet by 150 feet is available with less than 10 feet of overburden.

Other outcrops of dolomite may be found at the following locations:

1. *Cen. W. ½ W. ½ sec. 11, T. 39 N., R. 8 E.*—Five feet of Niagaran dolomite.
2. *Cen. sec. 27, T. 39 N., R. 8 E.*—Twelve feet of Niagaran dolomite.
3. *SW. ¼ SW. ¼ sec. 27, T. 39 N., R. 8 E.*—Eleven feet of Niagaran dolomite.
4. *NW. ¼ NE. ¼ sec. 33, T. 39 N., R. 8 E.*—Eighteen feet of Niagaran dolomite, along Fox River between St. Charles and Batavia.

KANKAKEE COUNTY

The bed rock of Kankakee County (fig. 35, p. 184) is Silurian in age, mainly Niagaran dolomite except for a belt 6 to 8 miles wide along the western edge where shale and sandstone of Pennsylvanian age or shale and limestone of Maquoketa age are found.

Though it conceals most of the bed rock, the overlying glacial drift is thinner on the average than in adjoining counties and rock is available at many places with only a thin cover of overburden.

In the latter part of the 19th century large quantities of rock were quarried in the county for use as building stone, but the use of concrete for construction purposes and the popularity of the Bedford stone are responsible for the abandonment of the building-stone industry in this county. Most of the abandoned quarries are found in the vicinity of Momence and Kankakee.

At the present time there is only one shipping quarry in the county. Rock for local use is quarried at several places.

SHIPPING QUARRY

L. No. 108

Lehigh Stone Company

The Lehigh Stone Company owns about 400 acres in sec. 7, T. 30 N., R. 14 W. The topography of the country is flat or gently rolling. The quarry located in the NW. ¼ of the section is worked as a pit. It is about 3,000 feet long and 600 feet wide, and has a 40-foot face. The overburden of sandy loam varies from 1 to 6 feet in thickness.

The rock is of Niagaran age, and is a finely crystalline, dense, white dolomite. The upper 30 feet is in beds 2 to 12 inches thick, which are often separated by thin laminae of shale. In the lower 10 feet the bedding is less distinct. Drilling shows the rock continuous in depth for at least 150 feet.

In quarrying, the face is worked as a unit, rather than in benches. Clipper churn drills are used in putting down the blast holes and 40 per cent dynamite is used in blasting.

The broken rock is loaded by steam shovels into 6-ton dump cars, and drawn to the tipple by locomotives. There a cable is attached and cars drawn up the tipple to the crusher (fig. 22).

Seven gyratory crushers and two roll crushers are used to crush the rock to the desired sizes. The gyratory crushers include a Superior No. 36, three 16-inch Superiors, two No. 6 Allis-Chalmers, one Austin No. 5, and 2 rolls, a Superior 36-inch and a Buchanan 24-inch.

Six screens, two 60-inch and two 48-inch, cylindrical, and two shakers are used to separate the crushed rock into the desired sizes.

Fig. 22. The crushing plant of the Lehigh Stone Company near Kankakee. The rock being quarried is the Niagaran dolomite.

The product is used for railroad ballast, road material, aggregate in concrete, and for agricultural limestone. From 5,000 to 6,000 tons of crushed rock are produced daily, and about 1,000,000 tons yearly. Storage is provided by bins with a 2,000-ton capacity.

Transportation facilities are provided by the New York Central and Illinois Central railroads.

POSSIBLE SHIPPING QUARRY SITES

L. No. 101

A large area in the vicinity of Aroma Park is underlain by rock at depths of less than 8 feet. Two abandoned quarries in the SE. ¼ SW. ¼ sec. 14, T. 30 N., R. 13 W. show that the overburden has an average thickness of less than 3 feet. It is probable that at least 320 acres are available with less than 5 feet of overburden.

The rock is Niagaran dolomite, but only 5 feet is exposed in the abandoned and water-filled quarries, and such rock as is exposed is so badly weathered that no satisfactory test sample could be obtained; nor was it possible to arrive at any satisfactory conclusion regarding its probable character when fresh. The rock probably continues in depth for about 100 feet.

The Cleveland, Cincinnati, Chicago and St. Louis Railroad crosses the area and no great difficulty would be experienced in obtaining transportation facilities.

Should this location be considered as a possible quarry site, the character and extent of the rock should be determined by diamond drilling.

L. No. 102

In the vicinity of Momence the region is nearly flat for some distance from Kankakee River, and bed rock is very near the surface as shown at two abandoned quarries, one south of the river in the NW. ¼ sec. 19, T. 31 N., R. 14 E., and the other near the center of sec. 18, T. 31 N., R. 14 E. At both these quarries the average overburden is less than 5 feet. The available acreage is large, probably as much as one section.

The old quarries are reported to be about 50 feet deep but are filled with water so that no good exposures are available. The rock is Niagaran dolomite and such of it as could be seen is so badly weathered and soft that no sample of the fresh rock was available. It is reported that the rock becomes harder in depth. This can easily be verified by core drilling.

The Chicago and Eastern Illinois Railroad crosses the area, and could provide transportation facilities.

It is probable that a more detailed examination of the county might reveal other areas where large quantities of rock may be obtained within reach of railroads, but because of lack of outcrops these areas can be discovered and their extent determined only by exploration with a drill.

LOCAL QUARRIES

L. No. 103 and L. No. 105

A brown dolomite of Niagaran age outcrops along Kankakee River and Rock Creek in the vicinity of Rockville.

The topography of the country is flat or gently rolling and it is probable that rock with less than 5 feet of overburden underlies the whole vicinity.

The fresh rock is a coarse-grained, buff dolomite but where weathered it has a brown, sandy appearance. The stone occurs in thin beds which average 6 inches and seldom exceeds one foot in thickness. At some localities they are separated by thin shaly partings. The greatest thickness of rock exposed is about 30 feet. Rock for local use has been quarried at several places in the vicinity.

L. No. 103

In the hillside southwest of Rockville in the SW. ¼ SW. ¼ sec. 32, T. 32 N., R. 11 E., there is an abandoned quarry about 75 feet long, in which the crusher house with a No. 2 Gates gyratory crusher and a set of screens still remains. Eleven feet of rock has been quarried with an average overburden of less than one foot.

L. No. 105

Rock for use on nearby roads was also obtained from the hill near the center NE. ¼ sec. 5, T. 31 N., R. 11 E., about a mile southeast of Rockville. A No. 3 crusher made by the Fleming Manufacturing Company was used to crush the rock. The quarry face is about 5 feet high and 75 feet long.

L. No. 106

Finely crystalline Niagaran dolomite in beds 2 to 12 inches thick has been quarried by Manteno Township in the NE. ¼ SE. ¼ sec. 28, T. 32 N., R. 12 E. The quarry is 100 feet long, roughly square in outline, and is worked as a pit. At the time of investigation the quarry was filled with water so that the height of the face could not be determined accurately. It is probably between 15 and 20 feet, however. The rock is buff in color and weathers to a soft, sandy-appearing rock which crumbles readily.

The overburden in the immediate vicinity of the quarry is a sandy loam which averages about 2 feet in thickness. It is probable that a considerable area in the vicinity is covered by less than 10 feet of overburden.

A No. 3 Gates gyratory crusher and a 2-foot screen were employed in crushing and sizing the stone.

The Illinois Central Railroad passes within one-fourth of a mile of the outcrop.

L. No. 107

Rock for use as agricultural limestone has been quarried in the SE. ¼ NE. ¼ sec. 20, T. 32 N., R. 12 E. about 1 mile west of Manteno.

The quarry is located in the side of a broad flat hill and shows a face of rock 15 feet high. The overburden is a brown, sandy loam ranging in thickness from 6 inches to 5 feet, but averaging probably about 2 feet. There are at least 10 acres in the vicinity on which the overburden does not reach a thickness of 10 feet.

The rock is of Niagaran age and is a finely crystalline, blue-gray dolomite in beds 1 to 12 inches thick. The middle 5 feet is in beds 1 to 3 inches, and is softer and more argillaceous than the upper and lower beds.

A No. 4 Gates gyratory crusher and a small Allis-Chalmers Hummer pulverizer were used in crushing the rock.

The Illinois Central Railroad passes about a mile east of the quarry.

KENDALL COUNTY

The rock outcrops observed in Kendall County are all of comparatively small extent and the overburden increases so rapidly that only small areas are available with less than 10 feet of overburden except at a few localities which are so far from railroads that transportation facilities are not obtainable (fig. 24, p. 136).

There are no shipping quarries in the county, but rock for local use has been quarried at several places. The most important and typical outcrops are described below.

LOCAL QUARRIES

L. No. 171

Rock is occasionally quarried by Kendall Township in the SW. ¼ sec. 23, T. 35 N., R. 7 E. The quarry is located in flat country and is worked as a pit. An oval area about 150 feet long and 100 feet wide has been excavated to a depth of about 8 feet.

The rock is of Galena age, and is a buff crystalline dolomite in beds 3 to 6 inches thick. Although only about 8 feet are exposed, the rock probably continues in depth for over hundred feet more.

A No. 1 Aurora Rock Crusher is used in crushing the rock.

The overburden consists of brown clay till having an average thickness of 3 feet. A large area is available under such conditions of overburden, but because of lack of exposures the exact limits can not be fixed without some exploration.

A No. 1 Aurora Rock crusher is used for crushing the rock.

L. No. 170

Lisbon Township operates a small quarry in the NE. ¼ SW. ¼ sec. 21, T. 35 N., R. 7 E. The quarry is located in flat prairie country and is worked as a pit. It is roughly circular in outline, and has a diameter of about 100 feet.

The quarry face shows 7½ feet of crystalline, gray and buff dolomite in beds 2 to 6 inches thick.

The overburden of brown clay till ranges in thickness from 2 to 5 feet. Possibly as much as 30 acres may be available with less than 5 feet of overburden.

A jaw crusher with a 10-by 20-inch jaw is used to crush the rock which is then screened to different sizes and used on local roads and as aggregate in concrete.

The Fox River and Illinois Union Electric Railway crosses the property.

The same formation outcrops at other localities in this vicinity suggesting that the surrounding region is underlain by rock with only a thin covering of overburden.

L. No. 165

Rock for crushed stone and agricultural limestone has been quarried from small, low rock hills in the flood plain of Fox River about half a mile north of Oswego, in the NE. ¼ SW. ¼ sec. 8, T. 37 N., R. 8 E.

Two circular pits about 100 feet in diameter were worked but are now filled with water.

The rock is a fine-grained, dense, gray dolomite of Niagaran age, and is found in beds 1 to 6 inches thick. About 13 feet is exposed. The overburden consists of brown clay till and averages about 2 feet in thickness.

The stone was blasted down, hand loaded into small quarry cars and pulled to the crusher by a cable. An Aurora Rock crusher No. 1 was used to break the stone, which was then sized by means of a 3- by 10-foot cylindrical screen.

An area of about 5 acres is included in these low hills.

The Aurora and Elgin Electric Railway is about a quarter of a mile west of these quarries.

OUTCROPS OF LOCAL IMPORTANCE

L. No. 164

About 14 feet of thin-bedded coarsely crystalline limestone outcrops in the valley of a small creek near the northern outskirts of Oswego in the NE. ¼ SW. ¼ sec. 17, T. 37 N., R. 8 E. The rock is of Maquoketa (Richmond) age and is underlain by shale with interbedded limestone.

The outcrop is about 2,700 feet long and for a distance of about 150 feet on each side of the creek has less than 5 feet overburden. Large amounts of stone may be obtained here for local use.

SE. ¼ sec. 1, T. 37 N., R. 6 E.

Along Big Rock Creek at the above location there is exposed 15 feet of fine-grained, buff-colored, cherty dolomite. The outcrop is about 1,100 feet long and for a width of about 150 feet has less than 10 feet of overburden.

SE. ¼ sec. 8, T. 36 N., R. 6 E.

About 6 feet of brown porous weathered Galena dolomite with thin irregular seams of pink chert, outcrops in the flood plain of Fox River, in the NE. ¼ SE. ¼ sec. 8, T. 36 N., R. 6 E., opposite Millbrook. The fresh rock is dense, coarse-grained, and dark gray in color.

The overburden rises rapidly back from the river but about 5 acres is available with less than 5 feet of overburden.

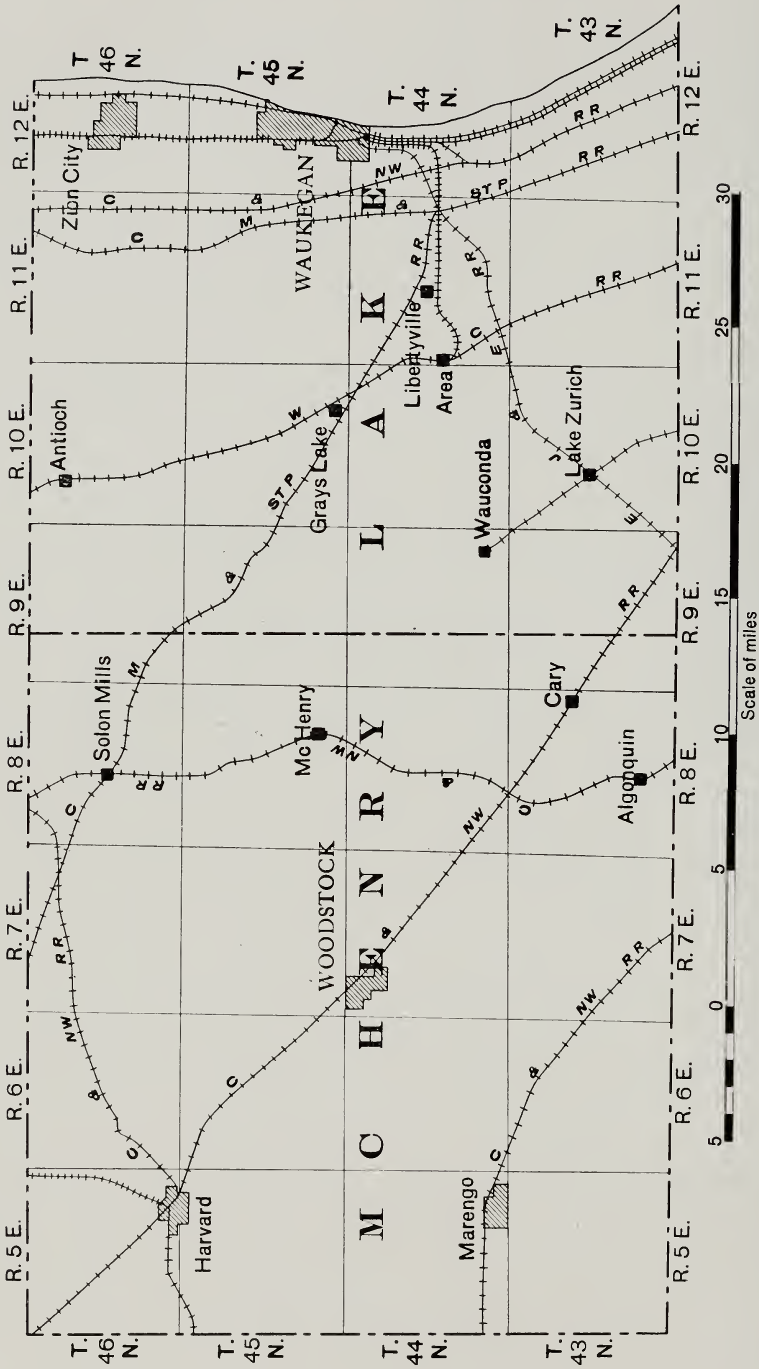

FIG. 23. Index map of Lake and McHenry counties.

L. No. 173

A coarsely crystalline limestone, in beds 3 to 8 inches thick, outcrops at several places along Aux Sable Creek in the southeast part of the county. The greatest thickness exposed is 3 feet. As the limestone is of Maquoketa (Richmond) age, probably shale will be found interbedded with it, but fairly pure limestone 3 feet thick may be obtained.

Only the rock along the river bank will be available without prohibitive thickness of overburden.

Outcrops were observed in the SW. ¼ sec. 15 and cen. sec. 22, T. 35 N., R. 8 E., and northern part of sec. 4, T. 34 N., R. 8 E.

NW. ¼ sec. 3, T. 36 N., R. 6 E.

An outcrop of 8 feet of Galena dolomite occurs along the lower slope of the east bluff of Fox River in the NE. ¼ NW. ¼ sec. 3, T. 36 N., R. 6 E. The outcrop is about 1,500 feet long but the overburden rises so rapidly from its edge that scarcely any width of rock is available with less than 10 feet of overburden.

LAKE COUNTY

The underlying rock of Lake County (fig. 23) is obscured by a heavy mantle of glacial drift except in a few places. Three exposures of limestone are reported[2], both of which are Niagaran dolomite. The first occurs in the NW. ¼ sec. 31, T. 44 N., R. 11 E., where about 6 feet of light gray limestone which weathers to buff is exposed in a small quarry. The overburden at the quarry is about 18 inches thick.

The other two exposures were encountered in wells in the NW. ¼ sec. 1, and in the NE. ¼ sec. 36, T. 44 N., R. 10 E., where limestone was struck at a depth of 4 and 5 feet respectively.

LA SALLE COUNTY

The limestones of this county (fig. 24) which are available in quantity and which might be used for road materials are the La Salle limestone, the Galena-Platteville dolomite, and the Shakopee dolomite of the Prairie du Chien group.

The La Salle limestone outcrops only along the bluffs of Vermilion and Little Vermilion rivers, and along Illinois River in the vicinity of La Salle. Its lithologic character varies greatly with the different beds and also from place to place. It is a dense nodular brecciated limestone and contains considerable argillaceous material either as interbedded shale

[2]Bannister, Henry M., Geology of Kendall County: Geological Survey of Illinois, vol. IV., p. 132, 1870.

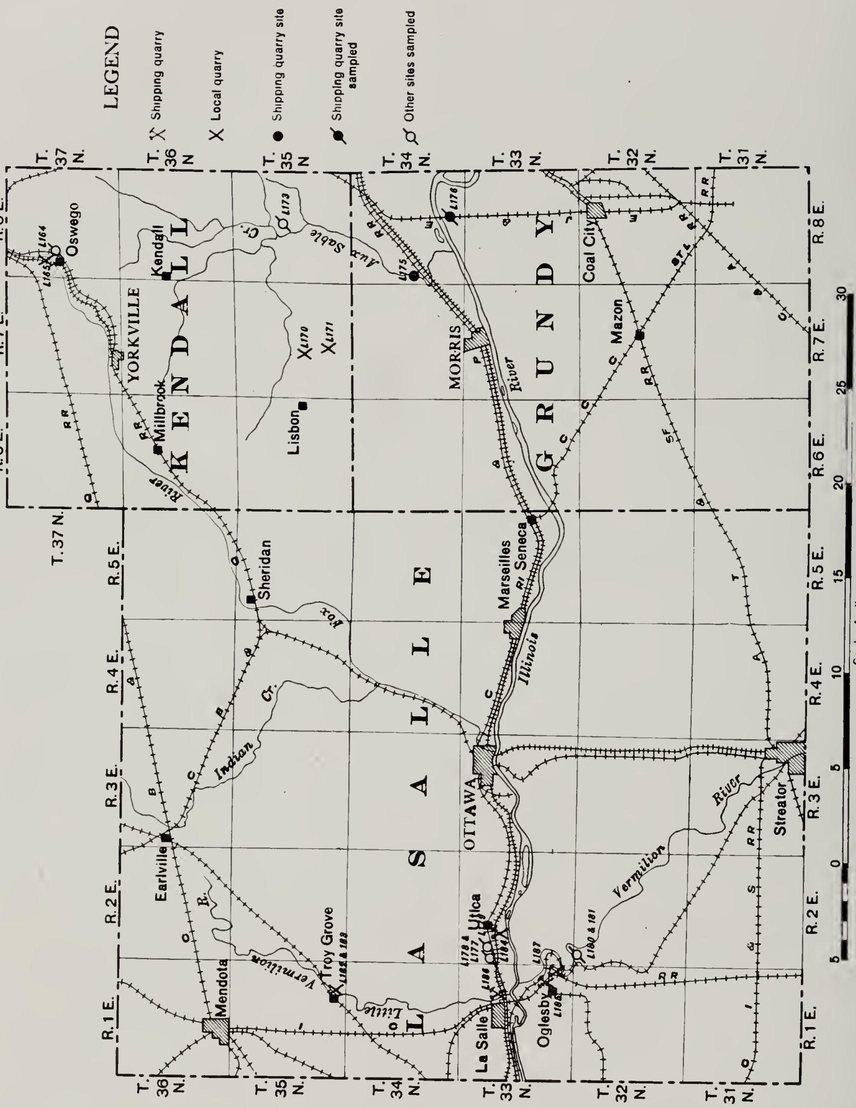

Fig. 24. Map of LaSalle, Kendall and Grundy counties showing location of quarries and quarry sites. Osage and Groveland townships in LaSalle county are not included.

or as impurities in the rock itself. Its variable character and the presence of shale make it of doubtful value for use as a source of good road material.

The most important outcrops of the Shakopee dolomite occur in the bluffs of Illinois River east of La Salle. This rock also shows great variation in character and contains many sandy and shaly beds which are comparatively soft. Certain beds of the Shakopee may be suitable for use as road material but their lack of uniformity in hardness and the softness

FIG. 25. Quarry of the Lehigh Portland Cement Company as seen from the quarry floor.

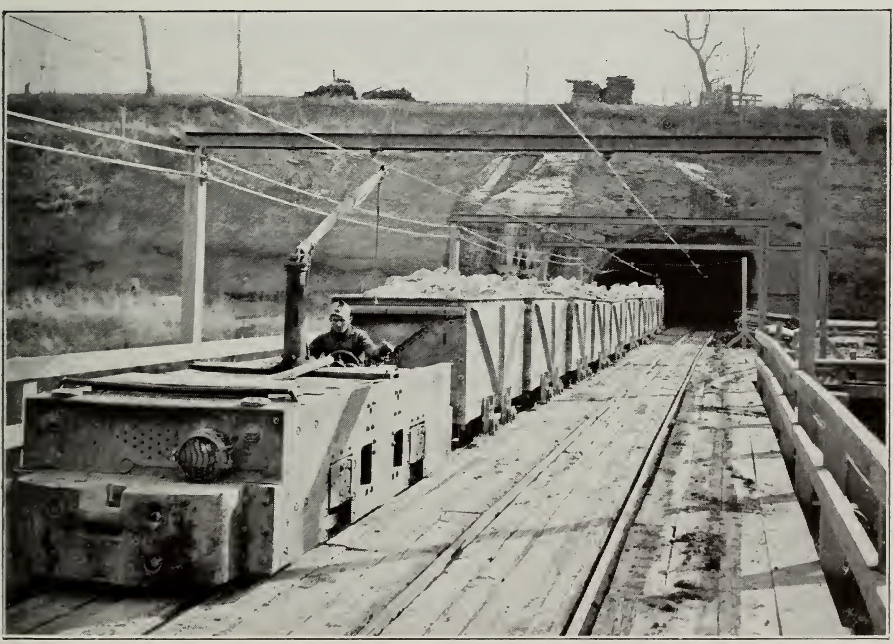

FIG. 26. Trainload of LaSalle limestone coming out of mine of the Marquette Portland Cement Company.

of the interbedded sandy and shaly layers will prevent the development of such deposits except on a small scale.

The Galena-Platteville dolomite which underlies the northern part of the county constitutes the most acceptable road material; but the rock is nearly everywhere so deeply buried by drift as to be unavailable except in small areas which are at considerable distance from railways.

SHIPPING QUARRIES

No quarries which ship crushed stone are known in the county. There are however 4 large quarries which produce stone for cement manufacture. They are briefly described and illustrate the method of quarrying.

Fig. 27. Loading LaSalle limestone with a compressed-air shovel in the mine of the Marquette Portland Cement Company.

L. No. 186

SE. ¼ NW. ¼ sec. 14, T. 33 N., R. 1 E.

Alpha Portland Cement Company

At this quarry a straight face of LaSalle limestone about 1300 feet long and 25 feet high is being worked. The holes for the heavy blasting are drilled with churn drills and sprung with 40 per cent dynamite. The broken rock is loaded by steam shovels into 6-ton cars and pulled to the crusher by locomotives. It is reduced to about egg size by a Fairmount roll crusher and three No. 5 Gates crushers after which the rock is run through hammer and ball mills until pulverized to the desired degree of fineness.

L. No. 185

SE. ¼ SW. ¼ sec. 25 T. 33 N., R. 1 E.

Lehigh Portland Cement Company

The quarry of the Lehigh Portland Cement Company is V shaped; the V is about two miles long. A face of LaSalle limestone 32 feet high is being worked (fig. 25). The holes for the heavy blasting are drilled with churn drills and the entire face is shot down at one time. The stone is loaded by steam shovels and pulled directly to the primary crusher by locomotives. The crushing battery consists of a No. 8 Gates, a No. 7½ Austin and a McCully, with hammer and ball mills for the final grinding.

L. No. 187

SE. ¼ NE. ¼ sec. 36, T. 33 N., R. 1 E.

The Marquette Portland Cement Company

Because of excessive overburden this company is mining its rock for cement (fig. 26). A 21-foot face of LaSalle limestone is worked and mining is carried on by the room and pillar method. The blast holes are drilled with tripod drills operated by compressed air. The broken rock is loaded by compressed-air shovels (fig. 27) into mine cars which are pulled to the primary crusher by electric locomotives. The cars dump directly from a cradle into a Power and Mining crusher with a 48- by 60-inch jaw, and the rock then passes to a secondary battery of two No. 8 Gates crushers and hammer and ball mills.

L. No. 184

Cen. NE. ¼ sec. 17, T. 33 N., R. 2 E.

Utica Hydraulic Cement Company

The Utica Hydraulic Cement Company[3, 4] is quarrying a 7-foot bed of Shakopee dolomite similar to that in the Illinois River bluff to the west. The rock occurs in a sort of island or low hill in the flood plain of Illinois River. The overburden consists of cherty Shakopee and is broken with dynamite and removed to abandoned portions of the quarry by steam shovels. The cement rock is drilled with air drills, shot down with 40 per cent dynamite and loaded into 1-yard cars by steam shovels. Two locomotives are used to transfer rock from the quarry to the kilns.

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[3] W. T. Christine. Cement, Mill and Quarry, p. 25, Mar. 5, 1923.

[4] Cady, G. H., Geology and mineral resources of the Hennepin and La Salle quadrangles: Ill. Geol. Survey Bull. 37, 1919.

LOCAL QUARRIES

L. No. 182 and L. No. 183

About 12 feet of fine-grained buff dolomite, in beds 1 to 6 inches thick, outcrops in the bank of Little Vermilion River east of Troy Grove in SW. ¼ NE. ¼ sec. 35, T. 35 N., R. 1 E.

The exposure is about 1800 feet long and though the overburden of clay till rises to heights of 20 feet or more back from the bank, there is a strip several hundred feet wide on which the overburden averages less than 10 feet.

Similar rock outcrops along the small creek which joins Little Vermilion River near the center of section 35. A thickness of 17½ feet is exposed for about 1500 feet along the bank and a strip of about 200 feet wide is available with less than 10 feet of overburden. The rock does not continue much below the base of the exposure for the underlying St. Peter sandstone outcrops a short distance south. Rock has been quarried for local use, and an Austin No. 1 crusher with a bucket belt, but no screen, is still at the quarry.

The Chicago and Northwestern Railway crosses the outcrop.

OUTCROPS FROM WHICH ROCK FOR LOCAL USE MAY BE SECURED

SE. ¼, sec. 7, T. 35 N., R. 5 E.

About 25 feet of fine-grained buff dolomite outcrops in the banks of Fox River in the NW. ¼ SE. ¼ SE. ¼ sec. 7, T. 35 N., R. 5 E., about 1½ miles southwest of Sheridan.

The outcrop in the east bank is about 500 feet long and a strip about 100 feet wide is available with less than 5 feet of overburden. The outcrop on the west bank is about 300 feet long, but here a strip only about 20 feet wide is available with less than 5 feet of overburden. The overburden is of clay till and increases in thickness away from the outcrop.

The Chicago Burlington and Quincy Railroad lies about 1 mile west of the outcrops.

L. No. 180 and No. 181

Stone for local use may be obtained from the La Salle limestone where it outcrops along Vermilion River and Bailey Creek near the center of sec. 6, T. 32 N., R. 2 E. The outcrops are limited to the banks of the streams but areas several hundred feet wide may be found on which the overburden is less than 10 feet.

The overburden consists of red clay and clay till and increases in thickness away from the creek and river banks.

A thickness of about 30 feet of rock is exposed. The section is as follows:

		Thickness Ft.	In.
5.	Clay shale, red, concretionary	5	..
4.	Limestone, thin-bedded, brecciated and nodular	15	8
3.	Shale, soft, gray clay	2	..
2.	Limestone like No. 4 (Sample No. 180)	8	..
1.	Limestone, coarse-grained, light gray, partly obscured (Sample No. 181)	..	..

The Chicago Burlington and Quincy Railroad is within 1000 feet of the outcrop, but at a level 20 feet higher.

L. No. 177, L. No. 178 and L. No. 179

The Shakopee dolomite comprises most of the north bluff of Illinois River between Utica and La Salle, T. 33 N., Rs. 1 and 2E.

The exposure is 70 feet high about one-fourth of a mile east of Pecumsaugan Creek but decreases to the east and west because the rock dips below the surface in both directions.

The overburden is St. Peter sandstone and clay till and has its maximum thickness near the extremities of the exposure. Near the middle of the exposure the overburden is about 15 feet thick and increases to about 30 feet away from the edge of the bluff. Near the edge of the bluff there are areas from 50 feet to several hundred feet wide where the overburden is less than 10 feet.

The right of way of the Chicago, Rock Island and Pacific Railroad is at the foot of the bluff.

The variability in the character of the different beds and the softness of some, make the rock of doubtful value as road metal.

LEE COUNTY

TOPOGRAPHIC RELATIONS

Topographically Lee County (fig. 28) may be divided into two units:—the northern half undulatory rolling and rough, and the southern half generally flat and prairie-like. Most of the outcrops are to be found in the northwest quarter of this county, where Rock River and its tributaries have produced a topography of marked dissection.

DESCRIPTION OF THE ROCK FORMATIONS

All the exposed rock of this county is of Ordovician age.

The Galena dolomite.—The Galena is a coarse-grained, coarsely crystalline, moderately hard, gray dolomite, which upon weathering becomes soft, porous and buff-colored, and on extreme weathering breaks up into small grains of dolomite resembling sand. The stone is in 1- to 10-inch beds and is not uncommonly associated with irregular masses or nodules of chert.

The Platteville limestone.—This limestone is composed of three distinct units:—(a) the upper buff beds, (b) the middle blue beds, and (c) the lower buff beds.

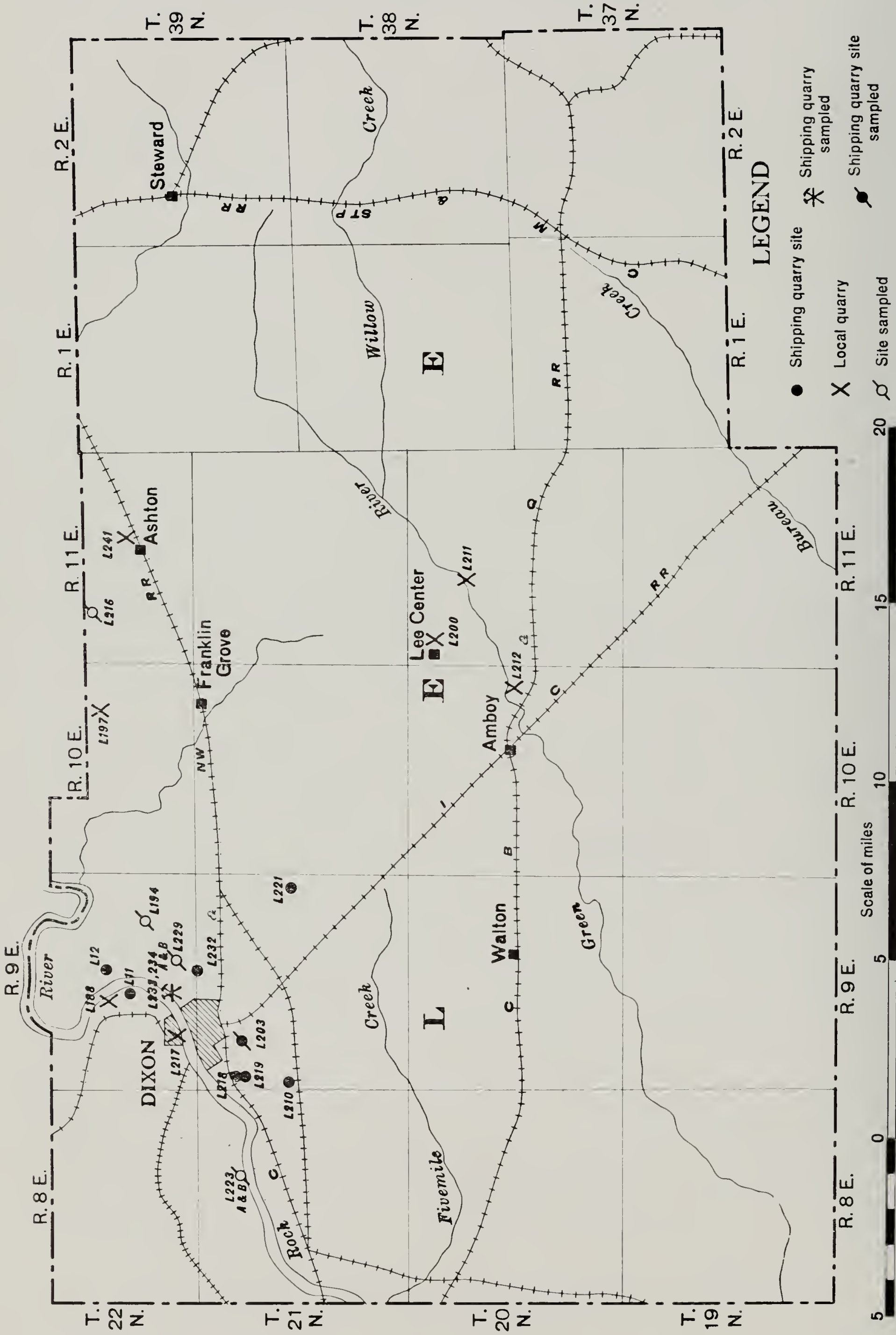

FIG. 28. Map of Lee County showing location of quarries and quarry sites.

The upper beds are moderately hard, fine-grained, finely crystalline, buff to brown limestone. The beds vary in thickness from 1 to 9 inches, but most of the rock is very thin-bedded, with a thin layer of brown sand residual from the weathering of the stone along the bedding planes, separating the beds. The rock as a whole seems to be rather susceptible to weathering.

The middle beds consist of layers of fine-grained, dense, finely crystalline, hard, brittle, blue limestone. It weathers slowly to thin slabs about an inch thick.

The lower buff beds are fine-grained, moderately hard, thin-bedded, finely crystalline limestone, mottled buff and gray. In general they do not seem to be quite so susceptible to weathering as do the upper buff beds.

FIG. 29. Quarry of the Sandusky Portland Cement Company near Dixon. The rock being quarried is Platteville limestone.

The St. Peter sandstone.—This formation consists of an aggregate of white rounded sand grains, locally iron stained, forming a loosely consolidated, massive sandstone. The sandstone is unsuited for use as road material.

The Lower Magnesian formation.—At the only quarried outcrop of the Lower Magnesian, it consists of coarse-grained dolomite, interbedded with thin layers of shale and sand.

SHIPPING QUARRIES

There are no quarries in this county shipping crushed stone. The quarry of the Sandusky Portland Cement Company produces no road material but a description is included as a matter of general interest.

L. No. 233, L. No. 234A, and L. No. 234 B

SW. 1/4 NE. 1/4 sec. 33, T. 22 N., R. 9 E.

The Sandusky Portland Cement Company

The quarry of the Sandusky Portland Cement Company is located in the east bluff of Rock River and is worked with a practically straight north-south face about 2000 feet long (fig. 29). Three well drills are used for drilling the holes for the heavy blasting and jack-hammers for making the holes for the smaller shots. The stone is loaded by steam shovels into 8-yard steel dump cars, pulled by locomotives to the primary crusher, a 48- by 60-inch Traylor jaw crusher. Two No. 5 McCullys and a set of Power and Mining Rolls further reduce the rock to a powder.

The overburden consists of 5 to 15 feet of buff clay, locally sandy and calcareous. It is loaded by steam shovel into 4-yard wooden dump cars and hauled either to the waste pile or to the plant for use in the cement mix.

The rock being quarried is the Platteville limestone and is a fine-grained, dense, brittle blue-gray stone in beds 2 to 40 inches thick. It is probably a part of the middle Platteville. Two samples, L. No. 234 A and L. No. 234 B were taken, the first from the lower 10 to 15 feet of the quarry face, and the second from the upper 10 to 20 feet. Since the Cement Company does not sell crushed stone these tests have no immediate bearing on the rock in the quarry where they were obtained. They do however, indicate what sort of tests may be expected from the fresh rock farther north in the bluff along the east bank of Rock River.

SITES FOR SHIPPING QUARRIES

L. No. 203

SW. 1/4 SW. 1/4 NW. 1/4 sec. 8, T. 21 N., R. 9 E.

The exposure three-quarters of a mile south of Dixon consists of 16 feet of fine-grained, soft, porous, mottled, buff, argillaceous Galena dolomite, the upper 10 feet of which is in beds 1 to 10 inches in thickness and the lower 6 feet in beds varying from 1 to 3 feet. The upper rock, close to the surface, is rather badly weathered and leached by surface water, but the rock improves in quality toward the bottom of the exposure and probably may be expected to improve as the rock is quarried deeper.

The quarry in which this rock is exposed, occurs in the upper part of a moderately steep slope to the north which flattens out gradually in its upper part. The approximate amount of rock available at this location, assuming 30 feet as a minimum thickness, is much over three-quarters of a million cubic yards with less than 10 feet of overburden. However, an east-west road cuts the tract with the most available rock supply into two almost equal parts, so that unless the road can be avoided the best site will be the area to the north of the road. This is the side toward the Chicago and Northwestern Railroad located about half a mile to the north and down grade. The Illinois Central Railroad lies three-quarters of a mile to the east over rolling country.

The quarry has been a county source of local road material.

L. No. 210

Cen. E. ½ SW. ¼ SW. ¼ sec. 18, T. 21 N., R. 9 E.

Two small quarries on the side of a gently sloping hill 2½ miles south of Dixon expose 28 feet of coarse-grained, moderately hard, somewhat porous, buff-gray Galena dolomite, in beds 2 to 8 inches thick. The stone is rather badly weathered on the exterior and presents a rough sandy appearance.

Around these quarries there is a tract of approximately 8 acres underlain by 28 feet of rock with less than 5 feet of overburden, and an additional tract about 25 acres in extent with 28 feet of rock and less than 15 feet overburden. The first area can furnish about 350,000 cubic yards of stone and the second about a million. The overburden consists of brown loam and glacial clay till. The Chicago and Northwestern Railroad right-of-way cuts the base of the hill a quarter of a mile south. A siding is possible.

L. No. 218

Cen. NE. ¼ NW. ¼ sec. 7, T. 21 N., R. 9 E.

This site located on the outskirts of Dixon is a hillside sloping gently to the north, cut midway by the Chicago and Northwestern Railroad. North of the railroad 13 feet of stone is exposed in a small quarry and to the south of the railroad the hill rises and exposes 30 additional feet of the same rock. Of these two locations the better for a large quarry is the one to the south of the tracks, where between one-half and three-quarters of a million cubic yards are available with an average of less than 10 feet of overburden. The overburden here consists of brown clay till.

The stone exposed is Galena dolomite, coarse-grained, rust yellow in color, occuring in beds 1 to 8 inches in thickness. In some places it is badly weathered and decayed to a dolomitic sand.

L. No. 219

SW. ¼ SW. ¼ NW. ¼ sec. 7, T. 21 N., R. 9 E.

One or two large hills composed of stone, with about 5 feet of overburden, are located 1 mile southwest of Dixon. The quantity of rock available in these hills is approximately over a million cubic yards.

The rock is the Galena dolomite, coarse-grained, soft, and crumbly. There is, however, no fresh rock exposed at the surface so that only the weathered stone is visible. An opening made into the fresh rock would probably expose stone moderately hard and gray in color.

The Chicago and Northwestern Railroad is 600 feet north of the hill.

L. No. 221

SW. ¼ SW. ¼ SE. ¼ sec. 13, T. 21 N., R. 9 E.

A large oval-shaped hill located 2½ miles southeast of Dixon contains about three-fourths of a million cubic yards of stone with less than 6 feet of overburden. The rock is exposed in a small quarry in one end of the hill where 22 feet of coarse-grained, soft, crumbly, rust-colored Galena dolomite, in beds 3 to 14 inches in thickness, is visible. The stone has been exposed to the action of the weather for some time and will probably be of much better quality where freshly quarried. The overburden consists of black and brown loam.

The Chicago and Northwestern Railroad is 400 feet north of the outcrop. The topography is favorable for the installation of a switch.

L No. 232

Center of north line of NW. ¼ sec. 3, T. 21 N., R. 9 E.

About 1½ miles east of Dixon, a small stream has cut a rather pronounced gully in a level tract, exposing 42 feet of Galena dolomite, which where fresh is moderately hard, fine grained, mottled buff and gray in color. Residents of the vicinity estimate that about 250 acres of stone are available with less than 4 to 7 feet of overburden. The rock is dry at its outcrop 42 feet below the general level of the country so an area of a few acres will furnish a very considerable quantity of rock. The Chicago and Northwestern Railroad is one mile to the south and the Illinois Central Railroad an equal distance to the northwest.

L No. 11

The bluff along the west bank of Rock River

Beginning at the center of sec. 28, T. 22 N., R. 9 E., a bluff composed largely of the Platteville limestone, extends northward along the west bank of Rock River. The bluff varies considerably, but in general consists of a relatively steep slope of bare or nearly bare rock, overlain by the overburden with its gentler slope. At almost any place along the bluff, rock might be quarried in amounts ample for local use. The best locations for shipping quarries, however, occur just south of Lowell Park, in the N. ½ of sec. 20, T. 22 N., R. 9 E. At this place the bluff ranges from 60 to 100 feet in height, and is composed largely of Platteville limestone with a thin capping of Galena dolomite where the bluff is the highest. The Platteville is a fine-grained dense hard gray-white stone, in beds 3 to 12 inches thick where fresh and in beds 1 to 3 inches thick where weathered. The Galena is coarse-grained moderately hard dolomite. These two formations undoubtedly extend back into the hills, and a large amount of good stone is available with less than 15 feet of overburden.

The Illinois Central Railroad runs along the top of the bluff about half a mile to the northwest, and could furnish transportation.

L No. 12

The bluffs north of the cement plant

In sec. 22, T. 22 N., R. 9 E., just north of the Sandusky Cement Plant quarry, on the east side of Rock River, there is a bluff some 110 feet high, composed of fine-grained, hard, brittle, dense, gray Platteville limestone, in beds from 1 to 8 inches thick. The bluff extends for at least 3,000 feet, and although the amount of overburden is problematical, it probably does not exceed 25 feet, and is probably less. The greatest difficulty encountered at this site is the lack of railroad transportation. The nearest railroad which is the switch extending into the quarry of the cement company lies from a half to three-quarters of a mile from the above-mentioned bluff. If the problem of transportation could be solved, this bluff would be a very favorable site for a shipping quarry.

Sec. 11, T. 21 N., R. 8 E.

In the center of sec. 11, T. 21 N., R. 8 E. along Rock River is a high bluff of limestone known locally as "The Rocks". It will supply a local demand and is close enough to a railroad to be a shipping possibility. At this site which is a private park an immense amount of stone is available.

LOCAL QUARRIES

L No. 188

NE. ¼ SE. ¼ SW. ¼ sec. 21, T. 22 N., R. 9 E.

A quarry 2 miles north of Dixon is operated in conjunction with the Dixon State Hospital. The quarry is crescent-shaped, and has a face about 300 feet long, 50 feet high, composed of dense, fine-grained, finely crystalline, hard, gray-colored Platteville limestone, in beds 3 to 13 inches in thickness. The rock breaks with a sharp edge and conchoidal fracture. The overburden is a brown clay till averaging about 7 feet in thickness.

The quarrying equipment consists of an Aurora Rock crusher, an Aurora well drill, a rotary screen with perforations ¾, 1, and ½ inches, bins with a capacity of 10 tons, and a gasoline engine for operating the crusher.

The entire 50 feet of rock is blasted down at one time using 40 per cent dynamite. At the face the rock is loaded by hand into two horse drawn dump carts and pulled to the crusher platform, where it is fed by hand into the crusher. The stone is hauled from the bins by trucks to the hospital grounds, where it is being used for the construction of a building and for local roads. The daily output is about 50 yards.

This quarry is favorably located to expand to a shipping one. The bluff in which it is situated extends along the west bank of Rock River for some distance above and below the quarry and the supply of stone is ample though a somewhat greater overburden may be expected farther back in the bluff and to the north of the present site. The Illinois Central Railroad about a quarter of a mile to the west, runs on top of the bluff at an elevation somewhat above that of the top of the quarry, so that a little different arrangement of the crushing machinery would probably be necessary to adapt the quarry for shipping. A railroad switch is topographically possible.

L No. 197

SW. ¼ NE. ¼ sec. 23, T. 22 N., R. 10 E.

A small quarry located 3 miles north of Franklin Grove exposes 16 feet of rather porous, moderately hard, buff, Platteville limestone in 3- to 12-inch beds interbedded with layers of sand and shale 3 to 7 inches thick. About 60,000 cubic yards are available with less than 10 feet of overburden.

The quarry has a straight face about 200 feet long from which the rock was loaded by hand into two horse-drawn dump carts and pulled to the crusher. The latter is a No. 20 Aurora Rock crusher. Bins having a capacity of approximately 40 yards are also a part of the quarrying equipment. The quarry is about three miles from a railroad and is therefore of purely local importance.

L No. 200

SE. ¼ SE. ¼ SE. ¼ sec. 6, T. 20 N., R. 11 E.

Eighteen feet of fine-grained, dense, hard, tough Platteville limestone, mottled brown in color, is exposed half a mile southeast of Lee Center. The upper 8 feet occurs in beds 3 to 6 inches in thickness and the lower 10 feet in beds 6 to 14 inches. The overburden is black soil and clay till, and varies in thickness up to about 25 feet. However, an ample supply of stone for local purposes is available, with less than 10 feet of overburden.

The crushing machinery in the quarry consists of a Wheeling Mold and Foundry Company crusher with a 12- by 6-inch jaw and a Bartlett Snow pulverizer, which have been used for crushing stone for local road construction and for agricultural purposes.

A railroad, formerly an electric line, lies half a mile to the north. The line is dismantled at present and is used as a switch line connecting with the Illinois Central at Amboy. If the rock rises in the hill and this rise is accompanied by a consequent decrease in the thickness of the overburden, and if the proper transportation can be secured, this site may be of interest as a site for a shipping quarry.

L No. 211

Cen. SW. ¼ sec. 9, T. 20 N., R. 11 E.

A pile of waste rock removed in excavating the Green River drainage canal has been the source of a supply of stone for road and agricultural purposes. The rock is Platteville limestone, fine grained, gray-buff, moderately hard to hard, and generally in thin slabs, of which more than half are over 6 inches in their longest dimension.

The crushing machinery consists of an Indiana Road Machine jaw crusher, a rotary screen 3 by 8 feet, with perforations 1 and 2 inches, and a bin with a capacity of about 35 yards. The rock is easily obtainable but is too far from a railroad to be of shipping importance.

L No. 212

NW. ¼ NW. ¼ sec. 24, T. 20 N., R. 10 E.

At this location a pile of waste rock similar to that at L No. 211 is found, except that the rock here is moderately coarsely crystalline, porous, rather soft, decayed Galena dolomite, with a brownish-purple color.

The crushing machinery consists of an Aurora Rock crusher No. 120 (jaw, 24 inches), a Western Rock crusher with a 12-inch jaw, and a 5-yard bin.

The waste pile is about a quarter of a mile northeast of the Chicago, Burlington and Quincy Railroad.

L No. 217

NW. ¼ NW. ¼ SW. ¼ sec. 32, T. 22 N., R. 9 E.

An unused quarry near the outskirts of Dixon exposes 40 feet of coarse-grained, rather soft, badly weathered, brown Galena dolomite, in beds 8 to 24 inches in thickness. About 1,000,000 cubic yards is available with less than 20 feet average overburden by working back the old face into the hill on the north.

A well-drill rig and a C-2 Bunnell Manufacturing Company jaw crusher comprise the machinery still on the premises.

A switch to the Illinois Central Railroad is located about a quarter of a mile south of the quarry, but an additional siding to the quarry would have to cross two streets, if this were to be made a shipping quarry.

L No. 241

NW. ¼ NW. ¼ NE. ¼ sec. 27, T. 22 N., R. 11 E.

A small quarry here exposes 21 feet of coarse-grained, coarsely crystalline, soft, granular Galena dolomite in beds averaging 6 to 8 inches. The upper 6 feet contains masses of gray and pink chert, which weathers locally to clinker-like masses. The overburden at the quarry is small and consists of black soil and red till.

The surrounding country especially that to the south and west, is underlain by this stone at no great depth, and by expanding in these directions and deepening, more than a million cubic yards of stone is available with less than 10 feet of overburden. The Chicago and Northwestern Railroad is half a mile to the southeast. The intervening country is gently rolling.

At this quarry there is an Indiana Road Machine crusher (jaw, 8 by 14 inches), a 25-yard bin, a bucket belt elevator, a slat screen, and a tractor.

The quarry has been operated by Ashton Township for local road stone.

Fig. 30. The Shakopee dolomite as exposed near Franklin Grove, Lee County.

LOCAL QUARRY SITES

The following sites, listed in Table 9, are too far from a railroad or contain too small an amount of stone to be considered as shipping quarry sites. They will, however, furnish an ample supply of stone for local purposes and from many of them rock has been quarried in comparatively recent years.

TABLE 9.—*List of local quarry sites in Lee County*

Reference number	Location				Description
	Township North	Range East	Section	Part of section	
....	22	8	35	Center S. ½ SW. ¼ SW. ¼	Thirty-three feet good Galena; overburden from 0 to 15 feet.
....	22	9	18	NE. ¼ SE. ¼ NE. ¼..	Seventy feet of stone; overburden averages 18 feet.
....	22	9	19	NW. ¼ SW. ¼ SW. ¼	Sixteen feet badly weathered Galena; overburden 5 to 20 feet.
....	22	9	22	NW. ¼ NW. ¼ NW. ¼	Thirty-six feet of Platteville. About 300,000 yards available with less than 10 feet of overburden.
L No. 194..	22	9	26	NW. ¼ NE. ¼ SE. ¼	Seventeen feet of Platteville; 12 to 15 feet of overburden.
....	22	9	30	SE. ¼ SE. ¼ NE. ¼..	Twenty feet good Platteville; overburden 0 to 18 feet.
....	22	9	33	SE. ¼ SE. ¼ SW. ¼..	Thirty-one feet of Platteville; 20 feet average overburden. About 50,000 yards available with less than 10 feet of overburden.
L No. 229..	22	9	34	Middle north line NW. ¼ SE. ¼	Twenty-four feet of fair Platteville; overburden 6 to 20 feet.
L No. 216..	22	11	20	NE. ¼ NE. ¼ NW. ¼	Ten feet of lower Platteville; 100,000 yards available with less than 10 feet overburden.
....	22	11	27	SE. ¼ NE. ¼ NW. ¼	Twenty-four feet of Galena; about 250,000 yards available with less than 10 feet overburden. Abandoned quarries north of Ashton.

TABLE 9.—*List of local quarry sites in Lee County*—Continued

Reference number	Location				Description
	Township North	Range East	Section	Part of section	
....	21	9	4	Middle south half SE. ¼ SE. ¼	Twenty-three feet badly weathered Galena: overburden 6 inches to 15 feet.
....	21	9	4	SW. ¼ SW. ¼ SE. ¼..	Twelve feet of badly weathered Galena; overburden 4 to 20 feet.
....	21	9	8	SW. ¼ SE. ¼ NE. ¼..	Twelve feet of badly decayed Galena overlying 18 feet of fair stone. About 25,000 yards available with less than 10 feet overburden.
....	21	9	28	SW. ¼ NE. ¼ NE. ¼	Fourteen feet of Galena; less than 6 feet of average overburden.
....	21	9	30	SW. ¼ SE. ¼ NE. ¼..	Eleven feet of Galena; overburden 2 feet.
....	21	10	2	NE. ¼ SE. ¼ NW. ¼	Twenty-one feet of Shakopee dolomite; 10 feet of overburden (fig. 30).
....	21	10	19	Middle of south line NW. ¼	Ten feet of fair Galena; overburden 6 to 15 feet.
....	21	8	2	NE. ¼ SE. ¼ SE. ¼..	Twenty-five feet of fair Galena; overburden 0 to 15 feet.
L. No. 223 A & B	21	8	10	SW. ¼ SW. ¼ NE. ¼	Twenty-six feet good Galena; overburden averages 10 feet. Sample A from upper 12 feet, B from lower 14 feet.
....	21	8	11	NW. ¼ NW. ¼.......	Thirty-five feet of Galena; overburden 0 to 15 feet, average 8 feet.

Table 9.—*List of local quarry sites in Lee County*—Concluded

Reference number	Location				Description
	Township North	Range East	Section	Part of section	
....	21	8	13	NE. ¼ NE. ¼ SE. ¼..	Twenty feet of fair Galena; 75,000 yards with less than 10 feet overburden.
....	20	10	28	SW. ¼ NW. ¼ NE. ¼	Nine feet fair Galena; overburden 5 to 15 feet.
....	20	10	29	NW. ¼ NW. ¼ SW. ¼	Five feet of Galena in a field.
....	39	2	25	SW. ¼ SW. ¼ NW. ¼	Twenty feet of good Galena; overburden 1 to 7 feet.

MC HENRY COUNTY

McHenry County (fig. 23, p. 134) is extensively covered with glacial drift which obscures the underlying rock, in all but a few places. Two exposures are reported.[5] About 2 miles east of Garden Prairie along the Chicago and Northwestern Railroad in T. 44 N., R. 5 E., there is exposed about 12 feet of thin-bedded, buff or bluish limestone, which locally contains much chert. The stone is probably one of the limestones of the Alexandrian (lower Silurian) series. The other outcrop of limestone in McHenry County occurs in a road cut in the NE. corner sec. 17, T. 44 N., R. 9 E., nearly on the county line. The exposed stone is the Niagaran dolomite and is light gray in color when fresh, but weathers to buff.

OGLE COUNTY

Ogle County (fig. 31) exhibits the general topographic dissection characteristic of regions bordering Rock River. In places, Leaf River and Pine Creek, tributaries of Rock River, have also produced a rugged topography and where they cut through masses of limestone, are not uncommonly flanked by rather precipitous bluffs.

The rock formations exposed in this county duplicate those of Lee County in number and character, except that the Galena dolomite shows a general increase in the thickness.

SHIPPING QUARRIES

There are no shipping quarries in Ogle County.

SITES FOR SHIPPING QUARRIES

Sites for shipping quarries are numerous in this county and in general occur in stream bluffs on hillsides. Quarries may therefore be developed by merely working into the outcrops rather than by the somewhat more expensive method of pit development. Following are brief descriptions of the best sites.

L No. 202

Cen. N. line NW. ¼ SW. ¼ sec. 2, T. 23 N., R. 10 E.

Forty feet of Platteville limestone is exposed 1 mile east of Oregon in two quarries which have been the source of a local supply of road material. In the west quarry the rock consists of a fine-grained, soft, argillaceous, gray-buff limestone in beds 2 to 10 inches thick. The rock in the lower 20 feet of the east quarry differs from that in the west quarry and in the upper portion of the same quarry. It is a very dense, hard, brittle, glassy-look-

[5]Bannister, Henry M., Geology of McHenry County: Geological Survey of Illinois, vol. IV., p. 132, 1870.

ing stone, which breaks with very sharp edges. This stone probably forms the basal portions of the hills of the vicinity which are capped with the more earthy limestone.

If measured from the top of the exposed rock to the summit of the hills the maximum overburden would be found to be about 40 feet. However, it is reported that the rock is encountered in post holes on the top of the hills so that the overburden which consists of sandy clay till is very much less than 40 feet.

An estimate of the available thickness of rock at this location is about 100 feet, judging from the height of the hills and the thickness of the rock in the wells of the vicinity. The hills themselves are of considerable size, such that at least one and a half million cubic yards of stone should be available in this vicinity.

The main line of the Chicago, Burlington and Quincy Railroad is about a mile to the south and a branch line running to Oregon about a mile to the west. In both cases the land slopes toward the railroad, but a switch to the main line would be preferable since it would not necessitate the crossing of Rock River.

Sample L No. 202A is from the westernmost quarry; sample L No. 202B is from the lower glassy looking stone in the easternmost quarry.

L No. 239

NW. ¼ NW. ¼ NE. ¼ sec. 33, T. 25 N., R. 10 E.

A small quarry east of Leaf River in the brow of a large ridge exposes 20 feet of Platteville limestone. The rock is coarse-grained, soft, vesicular, gray where fresh, but largely weathered to a rust-colored, loose, granular stone. The beds become progressively thicker toward the bottom of the quarry.

The partially timbered ridge in which the quarry is located rises gently to the south and is cut by even-sloped valleys. It is estimated that in this ridge probably about 30 acres is underlain by limestone with less than 5 feet of overburden. A large amount of stone is available at this place with less than 10 feet overburden—approximately about 500,000 cubic yards. If the quarried thickness of the rock is doubled, as it probably would be, were it to be worked on a commercial basis, the quantity of available stone would of course also be doubled.

At the base of the slope to the north, about 1,000 feet from the quarry, a siding is possible to the Chicago, Milwaukee and St. Paul Railroad.

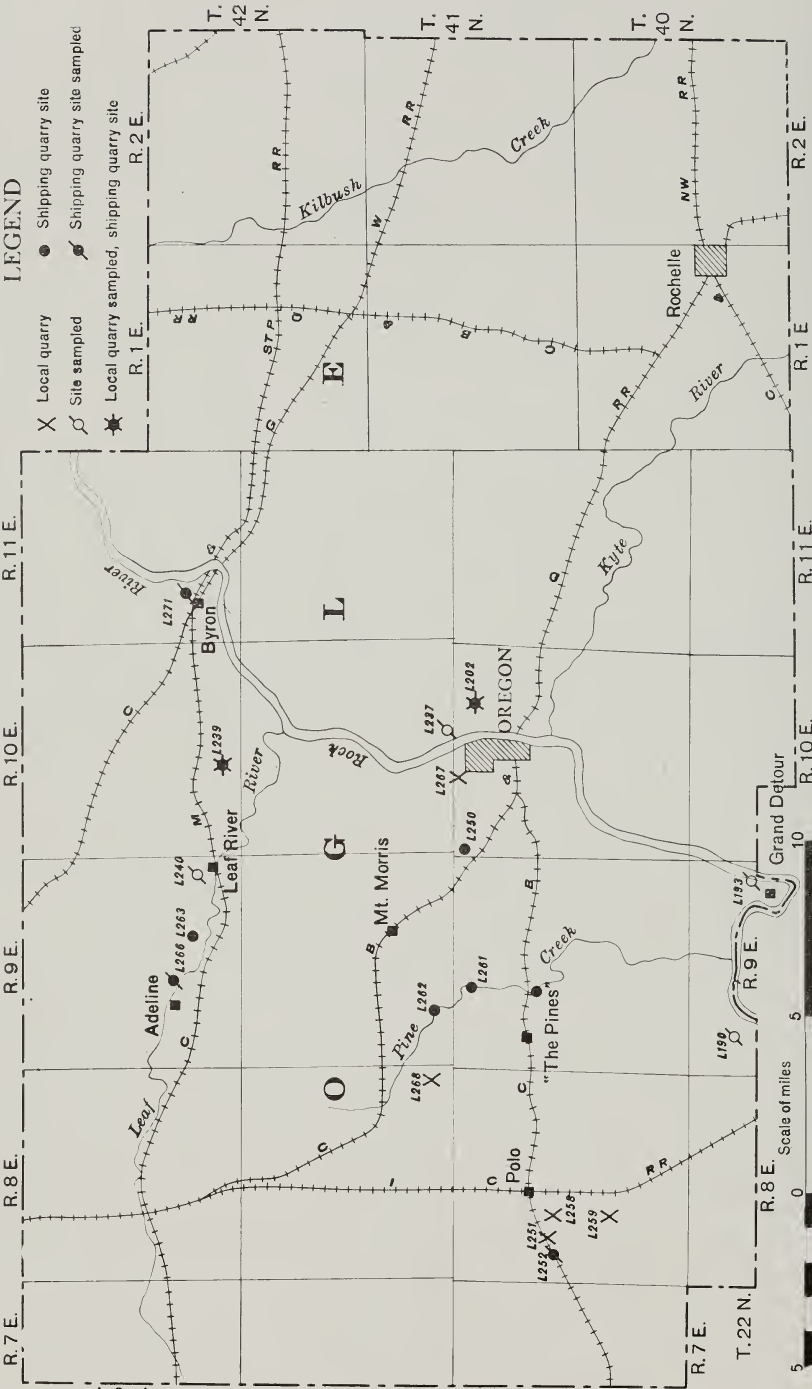

FIG. 31. Map of Ogle County showing location of quarries and quarry sites.

L No. 250

SE. cor. NW. ¼ sec. 6, T. 23 N., R. 10 E.

About 2½ miles west of Oregon a small quarry exposes 35 feet of Lower Magnesian limestone which is fine-grained, dense, buff-colored, hard, and in beds 1 to 6 inches thick. Near the top of the exposure, a thin band of chocolate and green shale is in evidence.

The exposure occurs in a large hill which will furnish about 400,000 cubic yards of stone with an average of less than 10 feet of overburden.

The Chicago, Burlington and Quincy Railroad goes partly around and cuts through the north end of the hill.

L No. 252

The bluff west of Polo

Beginning 1,000 feet west of the crossing of the Chicago, Burlington and Quincy Railroad and the northwest-southeast road in sec. 17, T. 23 N., R. 8 E., a bluff 60 to 80 feet high extends westward along the railroad for a little over a mile. The bluffs are due to erosion by a small creek, whose valley the railroad has used as a right-of-way.

The first large exposures at the east end of the bluff are found in a quarry (L No. 251) on the south side of the railroad and in another quarry, now abandoned but once the source of rock for lime, across the railroad. The rock at this place is the coarse-grained, moderately hard, tough, porous coarsely crystalline, brown and gray Galena dolomite, in beds averaging 8 to 15 inches in thickness.

About 500 feet farther west, stone is exposed which resembles the upper Platteville limestone or the transition beds of the Platteville and Galena. Still farther west the rock becomes characteristically Platteville, and is fine-grained, dense, hard, brittle, buff-colored, thin-bedded, with thin seams of clay and chert (fig. 32).

About 5,000 feet west, the middle blue layers of the Platteville appear in a small quarry overlain by the upper Platteville. As the beds rise to the west the blue stone finally forms the entire bluff at its western extremity. Sample L No. 252 comes from these blue layers. The blue stone is fine-grained, finely crystalline, hard, dense, brittle, in layers 4 to 12 inches thick, and contains masses of crystalline calcite. The bluff is somewhat lower here than at the east end, and from this place gradually lowers and flattens to the west.

The overburden, especially near the immediate edge of the bluff, is generally only about 10 feet and is composed of clay till.

Because of the ease of transportation, the relatively great thickness of stone available, and the small amount of overburden, this bluff would make a good quarry site. Back from its face the land flattens rapidly and is probably underlain by rock at no great depth. Almost a million and a half cubic yards of stone are probably available.

The distance of the face of the bluff from the railroad varies on both sides of the creek and certain localities offer better conditions for the construction of switches and quarry buildings. A consideration of such matters would belong in a more detailed investigation.

L No. 261

Pine Creek bluff south of the east-west road in sec. 4, T. 23 N., R. 9 E.

From a point about 2,000 feet south of the east-west wagon road in sec. 4, T. 23 N., R. 9 E., a bluff of Galena dolomite extends in an approxi-

Fig. 32. Quarry in the Platteville limestone on the Lowden farm near Oregon in the SW. ¼, NE. ¼, sec. 23, T. 23 N., R. 10 E.

mate southerly direction along Pine Creek for about 2,000 feet. The dolomite appears in both banks along the creek, extending for 1,900 feet in the east bank and 1,000 feet in the west. Both bluffs have the same southern termination about 1,000 feet north of the Chicago, Burlington and Quincy Railroad.

The unweathered Galena found here is a moderately coarsely crystalline, medium coarse-grained, moderately hard, gray stone. It occurs in beds varying from 1 to 24 inches in thickness and stands persistently in steep, sheer faces.

In the bluff on the east side of the creek, a thickness of from 50 to 60 feet of stone with less than 10 feet of average overburden, is exposed or at least suggested, over an area along the top of the bluff from 150 to 200 feet wide.

The west bluff is less precipitous than the east, and exposes in general a lesser thickness of stone. The quarriable stone in this bluff has an average exposed thickness of about 45 feet. Because the slopes are relatively gentle, the overburden has washed down over the rock face in some places and obscured portions of it. This decreases the apparent thickness of rock and increases the apparent thickness of the overburden. The thickness of rock probably rather closely approximates that in the east bluff so that a strip about 150 feet wide with 45 feet of stone is available with less than 15 feet of overburden.

L No. 262

The Pine Creek bluff in sec. 32, T. 24 N., R. 9 E.

Beginning at the junction of Pine Creek and the wagon road, a bluff of Galena dolomite extends northwest along the creek for 1,000 feet in the northeast bank and beginning about 400 feet north from the road extends 1,900 feet in the southwest bank (fig. 33).

To the northwest both bluffs disappear with a few local recurrences, where the stream cuts through hills. This is especially true on the northeast side, where about 2,300 feet from the road the stream cuts through a hill and exposes 45 feet of stone for a distance of about 500 feet.

In the southwest bank the exposed thickness of rock varies from 30 to 60 feet and averages about 45 feet. The southern end of the bluff is grass covered; 800 feet north of the road the bluff is composed of 45 feet of rock, with an area 200 feet wide overlain by less than 15 feet of overburden; 1,000 feet north the bluff shows 55 feet of rock with a strip 250 feet wide overlain by less than 15 feet of overburden; 1,400 feet north the bluff is rather gentle and exposes 45 feet of stone with an area about 100 feet wide overlain by less than 15 feet of overburden; finally, at about 2,350 feet north of the road the bluff becomes low and grass covered so that the rock core is entirely obscured.

The northeast bluff is much smaller than the southwest. About 400 feet north of the road the bluff is covered but gradually it becomes higher and at 675 feet north of the road is 28 feet high, with a maximum overburden of 15 feet. At 1,075 feet north, 33 feet of rock is exposed with the same amount of overburden. Finally, at 1,500 feet north of the road the bluff disappears and is grass covered.

The Galena here is a coarsely crystalline, coarse-grained, rather soft, porous, buff dolomite, in beds averaging 8 to 14 inches in thickness.

The Chicago, Burlington and Quincy Railroad may be reached 2 miles to the north for the north branch line and 2⅓ miles to the south for the south branch line.

L No. 263

SW. ¼ SE. ¼ SE. ¼ sec. 27, T. 25 N., R. 9 E.

Ten feet of fine-grained, dense, moderately hard, earthy, buff Platteville limestone in beds 1 to 6 inches in thickness outcrops 1½ miles west of Leaf River. Chert seams are common. This outcrop occurs in the south end of a hill extending some 2,000 feet to the north. The vertical distance

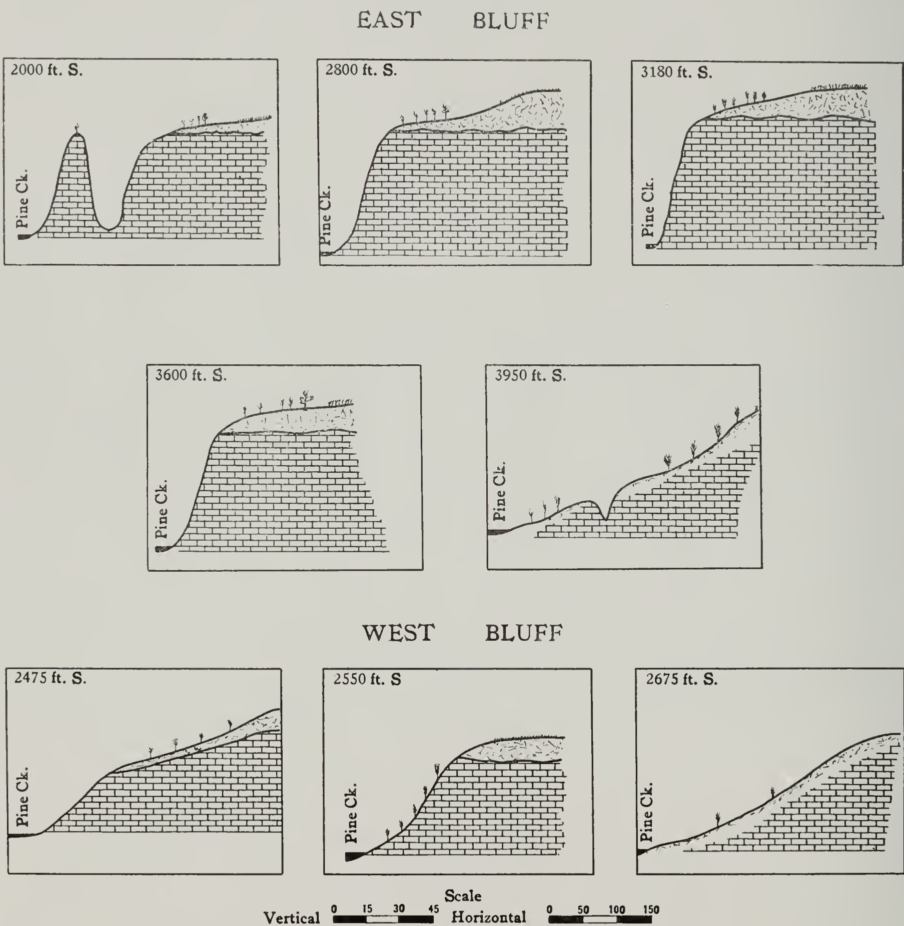

Fig. 33. Diagrammatic cross sections of the bluff of Galena dolomite along Pine Creek in sec. 32, T. 23 N., R. 9 E. Sections located south of east-west road. Both vertical and horizontal scales in feet.

from the top of the exposed stone to the top of the hill is 25 feet, an interval which should be considered overburden if the rock does not rise in the hill. It is probable, however, that the rock rises in the hill so that the overburden will probably average more nearly 15 than 25 feet. From the information secured, it is estimated that about 10 to 12 acres should be available in this hill with at least 25 feet of stone and less than 15 feet of average overburden.

The Chicago, Milwaukee and St. Paul Railroad is about half a mile to the south. The intervening country is hilly.

L No. 266

Sec. 21, T. 25 N., R. 9 E.

Bluffs on Leaf River

Extending north along the east side of Leaf River, and beginning at the road bridge, near the center of the south line of sec. 21, T. 25 N., R. 9 E., 1 mile east of Adeline there is a marked bluff composed of Galena dolomite underlain by Platteville limestone. The Platteville is poorly exposed and shows only near the road bridge. The Galena, however, is the principal bluff-forming rock and is a coarse-grained, moderately hard to hard, coarsely crystalline, gray-buff dolomite occurring in heavy beds.

The height of the bluff varies considerably and reaches its maximum about half a mile from the road, where 120 feet of stone is exposed. Measured from the stream level the height to the top of the bluff is about 135 feet, and the available thickness of rock about the same. Most of the bluff is precipitous, with occasional steps formed by heavy ledges of the Galena dolomite. Back from the edge of the bluff the overburden rises gently through a timbered tract to the cultivated area above. The area with less than 15 feet of overburden varies at different places, but on the average a strip about 150 feet wide is available with less than 15 feet of overburden.

The nearest railroad, the Chicago, Milwaukee and St. Paul, is 1⅛ miles to the south over rough country.

L No. 271

SE. ¼ SW. ¼ sec. 29, T. 25 N., R. 11 E.

This exposure occurs in a moderately large quarry located in the southeast end of a large hill about three-quarters of a mile northeast of Byron, and evidently was once the source of local stone for roads. It consists of 61 feet of Platteville limestone. The limestone shows marked horizontal and vertical variations and is probably middle Platteville. It consists of layers of blue, fine-grained, dense, hard, brittle, finely crystalline stone which grades laterally and vertically into fine-grained, finely crystalline, hard, brittle, buff limestone, somewhat coarser than the blue stone. The latter is found scattered throughout the entire 61 feet, and is nowhere continuous vertically for more than 5 feet nor horizontally for more than 15 feet. About 80 per cent of the entire exposure is the buff-colored stone and the remaining 20 per cent the blue stone. The blue stone is found in beds 1 to 3 inches thick, and the buff is a little heavier bedded, beds averaging 5 inches in thickness. The buff colored stone, however, weathers to the thin slabs similar to that of the blue.

This hill has an area of about 12 acres and, if an average thickness of 40 feet of rock is assumed, it will furnish about a million cubic yards of rock with less than an average of 10 feet of overburden. As the quarry is not at the base of the hill, the thickness of rock and consequently the quantity available may be increased about two fold if the stone is quarried to a depth of 40 feet more.

The Chicago, Milwaukee and St. Paul Railroad is about fifteen hundred feet to the south, at a somewhat lower elevation than that of the floor of the quarry. Topographically a switch is possible.

Sec. 9, T. 23 N., R. 9 E.

The bluffs of Pine Creek, at "The Pines"[6]

Extending south for about one mile from the Chicago, Burlington and Quincy Railroad tracks, there is a bluff of Galena dolomite along Pine Creek. The stone is a coarse-grained, coarsely crystalline, moderately hard, buff to gray, heavy-bedded dolomite, similar to that found elsewhere in this county.

The height of the bluff measured above the level of the stream varies from a minimum of 15 feet to a maximum of 60 feet, but in general averages about 40 feet. Where the bluff is the highest the rock usually stands in a steep, precipitous face which may extend down to the creek without interruption or may be covered at its base by talus. Where the bluff is lower the slopes are moderate or gentle, and are commonly covered with vegetation, as are also the uplands rising away from the steeper slopes. The exact amount of overburden is therefore indeterminate without detailed work with a drill. At the steeper faces, however, the overburden is probably not great, considering the thickness of the stone, which appears to increase back from the edge of the bluff. The overburden consists of black soil, and clay till covered with a growth of scrub trees and some large pines.

The best location for a quarry would be near the Chicago, Burlington and Quincy Railroad, where 40 feet of rock are available with a relatively small overburden. The next best location is at the other end of the bluff, about five-eighths of a mile from the railroad. Here 60 feet of stone is available with a relatively small amount of overburden also.

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[6]"The Pines" is a privately owned forest preserve, so-called because of the large indigenous pine trees which it contains.

LOCAL QUARRIES

L No. 202

Cen. W. ½ W. ½ sec. 2, T. 23 N., R. 10 E.

This site has been described fully under sites for shipping quarries (p. 155). It is now the source of a local supply of road material and is equipped with an Aurora Rock crusher, model G 120.

L No. 239

NW. ¼ NW. ¼ NE. ¼ sec. 33, T. 25 N., R. 10 E.

This site has also been fully described under shipping quarry sites (p. 157). It is equipped with an Aurora Rock crusher No. 3 and a tractor, and has been the source of local road material.

L 251

SE. ¼ NW. ¼ NW. ¼ sec. 17, T. 23 N., R. 8 E.

This site 1¾ miles west of Polo has already been mentioned in a general way in connection with the discussion of the Polo bluff. More particularly, however, at this place there is a quarry which exposes 40 feet of coarse-grained, moderately hard, tough, porous, brown and gray Galena dolomite, in beds averaging from 8 to 15 inches in thickness, with local seams of white chert from 1 to 4 inches thick. Located as it is, in a large bluff, this quarry is capable of affording a great amount of stone with a small overburden.

The quarry is roughly semi-circular and has a face 300 feet in length The quarrying and crushing apparatus consists of an Ingersoll-Rand jack hammer, an Aurora Rock crusher (jaw 12 by 18 inches), a rotary screen, 2 by 5 feet with perforations ½ and 1½ inches, a Nichols steam tractor, and a 75-yard bin. The entire 40-foot face is blasted at one time with 40 per cent dynamite. The stone is hand loaded into horse-drawn dump carts and pulled to the crusher platform.

L No. 258

SW. ¼ SE. ¼ NE. ¼ sec. 17, T. 23 N., R. 8 E.

A small quarry one mile southwest of Polo exposes 21 feet of fine-grained, dense, moderately hard, finely crystalline, thin-bedded (1 to 8 inches), buff Platteville limestone, interbedded with layers of shale and chert. The stone is rather badly broken and decayed at the top of the quarry especially.

The overburden at the edge of the quarry is about 10 feet thick and rises to about 20 feet in a short distance, so that this quarry will not be the source of any great amount of stone.

An Aurora Rock Crusher No. 1 and a 30-yard bin are on the premises.

L No. 259

Cen. SE. ¼ SE. ¼ sec. 20, T. 23 N., R. 8 E.

The quarry 2½ miles southwest of Polo is in the tract adjoining a barnyard and as the face is being worked back toward the farm buildings, the present quarry is limited to a few more thousand yards of stone.

The exposure consists of 18 feet of soft, porous, frothy, buff Galena dolomite. In places it has weathered to a soft, earthy mass, especially toward the top of the quarry. The lower part of the exposure is in heavy beds but even in them the stone is very soft and crumbly and is easily powdered to a dust.

The stone is being used in the construction of a local water-bound macadam road. The quarrying equipment is owned by the contractors who are building the road and consists of two Ingersoll-Rand steam drills, a Thew steam shovel with a one-yard bucket, an Aurora Rock Crusher No. 1, a flat steel grating with ½-inch perforations, and two horse-drawn one-yard carts. The stone is blasted down in one 18-foot bench or as two 9-foot benches loaded by hand to the carts, pulled to the crusher and fed into it by hand. The daily output is about 30 yards.

L No. 267

Center NW. ¼ NW. ¼ sec. 4, T. 23 N., R. 10 E.

The quarry 1 mile northwest of Oregon is located in a hill which is also the site of the Oregon city reservoir. In order to prevent cracking the concrete reservoir, only very small shots are used in blasting down the rock in the quarry. Despite this handicap a considerable amount of stone has been, and is being removed, for local road work. A local supply is still available.

The stone exposed is of Platteville age and consists of a fine-grained, finely crystalline, hard, brittle, dense, buff, earthy limestone in beds 4 to 16 inches thick.

The quarrying and crushing machinery consists of an Aurora Rock Crusher No. 1, a rotary screen, 2 by 6 feet with ½- and 1¾-inch mesh, a 60-yard bin, a Fordson tractor, and a steam boiler. The quarry is worked by hand.

L No. 268

SW. ¼ SW. ¼ NE. ¼ sec. 36, T. 24 N., R. 8 E.

About 5 miles west of Mount Morris there is exposed 22 feet of moderately hard, moderately coarse, crystalline, gray-buff dolomite in beds 1 to 14 inches thick at the weathered surface but thicker where fresh.

The exposure occurs in the banks of a small creek and extends 540 feet upstream from the road. An area about 125 feet wide is available with an average of less than 10 feet of overburden and will furnish about 50,000 cubic yards of stone.

Preparations are being made for opening a small quarry for use in the construction of a mile of local road and the following apparatus is on the ground:—an Aurora Rock Crusher No. 1; a portable bin with a cylindrical screen 2 by 6 feet with ½-inch perforations; a well drill; and a Keystone steam shovel (one-yard bucket).

LOCAL QUARRY SITES

Table 10 gives the sites which have supplied or are capable of supplying local demands for stone. Most of them are too far from the railroad to be shipping possibilities, and many have too small a quantity of available rock to be of commercial importance.

In the table the thickness given for the rock is the exposed thickness; the thickness of the overburden is the average over the area which contains the amount of rock available.

TABLE 10.—*List of local*

Ref. No.	Town-ship N.	Range E.	Sec.	Part of section	Formation	Thick- Rock
						Feet
....	25	8	10	E. line	Platteville.....	....
....	25	9	22	NW. ¼ NW. ¼ NW. ¼....	Platteville.....	10
240	25	9	25	Center S. ½..............	Platteville.....	22
....	25	10	8	SW. ¼ NE. ¼ NW. ¼.....	Platteville.....	14
....	25	10	33	SW. cor.	Platteville.....	24
....	25	11	23	N. ½	Galena........	10
....	25	11	26	W. ½ S. line.............	Platteville.....	3
....	25	11	27	N. ½	Platteville.....	....
....	25	11	27	SW. ¼ NE. ¼ SW. ¼.....	Platteville.....	9
....	25	11	32	S. ½ NE. ¼ SE. ¼........	Platteville.....	28
....	25	11	34	Center S. line............	Platteville.....	15
....	24	7	25	Cen. NE. ¼ SE. ¼ SE. ¼..	Galena........	30
....	24	8	2	SE. cor.	Galena........	14
....	24	8	5	SE. ¼ NW. ¼ NE. ¼......	Platteville.....	17
L 237	24	10	34	Center S. ½..............	Platteville.....	50
....	24	11	4	SE. ¼ SE. ¼ SW. ¼......	Platteville.....	38
....	24	11	9	NW. ¼ SW. ¼ NW. ¼....	Platteville.....	31
....	24	11	21	Center NW. ¼...........	Platteville.....	32
....	23	8	7	Middle S. line NW. ¼ SW. ¼	Galena and Platteville	33
....	23	9	14	NW. ¼ NE. ¼ NE. ¼.....	Galena........	28
....	23	9	16	NW. ¼ SW. ¼ SW. ¼.....	Platteville.....	41
....	23	9	17	Center SW. ¼ SW. ¼.....	Platteville and Galena	18
....	23	9	25	Center W. ½ SW. ¼ NE. ¼	Platteville.....	22
....	23	9	27	South ½	Platteville.....	25
....	23	10	3	Middle E. ½ E.-W. line bisecting sec.	Platteville.....	36
....	23	10	23	SW. ¼ SW. ¼ NE. ¼.....	Platteville.....	30
....	23	10	26	SW. ¼ SW. ¼ NE. ¼.....	Platteville.....	7½
....	23	10	35	Center SE. ¼.............	Galena........	5
....	23	11	3	Center W. ½..............	Platteville.....	12
....	22	9	8	SW. ¼ NW. ¼ NW. ¼.....	Platteville.....	40
....	22	9	3	SE. ¼ NW. ¼ NW. ¼.....	Platteville.....	18
....	22	10	12	NE. ¼ NE. ¼ SW. ¼......	Platteville.....	14
....	22	10	4	SE. ¼ SE. ¼ SE. ¼.......	Platteville.....	18
....	22	11	5	NW. ¼ SE. ¼ SW. ¼.....	Platteville.....	6
....	42	1	28 & 34	....	Galena........	15
....	42	1	32	SE. ¼	Galena........	....
....	41	1	7	....	Galena........	....

quarry sites in Ogle County

ness Over-burden	Where exposed	Amount available	Distance to railroad	Remarks
Feet		*Yards*	*Miles*	
Moderate	Road............	Local supply	....	....
5—	Hillside..........	75,000±	2½ South.....	....
20—	Hillside..........	100,000±	1 South.......	....
8—	Hillside..........	90,000	1 South.......	....
10—	Road cut.........	375,000±	1½ North.....	....
....	E.-W. road.......	Local supply	....	....
Slight	In road..........	Local supply	....	....
Slight	E.-W. road.......	Local supply	....	....
....	Hillside..........	Local supply	....	Small quarry
10—	R. R. cut and hill-side	Relatively small amount	....	....
5—	Hillside..........	Local supply	Close.........	Abandoned quarry
10—	Creek banks......	170,000	4 South.......	....
10—	Creek banks......	40,000	2 West........	....
10—	Hillside..........	140,000±	1 East.........	....
20—	Valley sides......	500,000±	2½ South.....	Very thin-bedded and variable
10—	Creek Bluffs......	300,000±	1 South.......	....
10—	Creek Bluffs......	500,000±	1¾ Northeast..	....
10—	Creek Bluffs......	Large amounts	2¾ North.....	....
10—	Hillside..........	140,000±	1 South.......	....
10—	Creek bank and road	Ample supply	....	....
12—	Creek bluff.......	200,000±	1½ North.....	....
10—	Creek bluff.......	Ample local	1½ North.....	....
10—	Hillside..........	35,000±	3 North.......	....
10—	Along Pine Creek.	Large amount	6 Southwest...	....
10—	Valley sides......	225,000±	2 Southwest...	....
5—	Hillside..........	600,000±	2½ Northeast..	....
10—	Hill..............	5,000±	2¾ North.....	....
Heavy	In field..........	....	....	Poor stone; soft and granular
5—	Hill..............	Sample local	2¼ South.....	....
20—	Creek bluff.......	1,000,000±	3½ South.....	....
10—	Creek bluff.......	15,000±	4¾ North.....	....
10—	Road cut.........	100,000±	7 North.......	....
10—	Creek bluff.......	130,000±	5½ South.....	....
5—	Hill..............	350,000±	4 Northeast....	....
Heavy	Cut of C. G. W. R. R.	Possible local supply	On railroad....	....
....	Small quarries....	Local supply	....	....
....	Stillman Creek...	Local supply	....	Scattered outcrops

TABLE 10.—*List of local quarry*

Ref. No.	Town-ship N.	Range E.	Sec.	Part of section	Formation	Thick- Rock
						Feet
....	41	1	17	Middle N. line.............	Galena.......	8
....	41	1	26	SE. ¼ SW. ¼ NW. ¼.....	Galena.......	....
....	41	1	31	SE. ¼ SE. ¼ SE. ¼.......	Platteville....	17
....	41	1	32	NW. ¼ NW. ¼ NE. ¼.....	Platteville....	11
....	41	2	8	Center E. ½...............	Galena.......	15
....	41	2	29	SE. ¼ NE. ¼ NE. ¼......	Galena.......	....
....	41	2	9	NE. ¼ NE. ¼ SW. ¼......	Platteville....	10
....	40	1	13	SE. ¼ SE. ¼ NW. ¼......	Galena.......	11

The Rock River bluff, particularly along the west bank, contains a large amount of Platteville and Galena favorably situated for quarrying. No railroad facilities within two miles confine the use of the stone to local purposes.

sites in Ogle County—Concluded

ness Over-burden	Where exposed	Amount available	Distance to railroad	Remarks
Feet		*Yards*	*Miles*	
5—	Small quarry.....	Local supply	....	Partly filled
....	Small quarry.....	Local supply	....	....
5—	Small hill........	50,000	1¼ Southwest.	....
7—	Hillside..........	75,000±	1¾ East......	....
....	Small quarry.....	Local supply	....	Quarry being filled
....	Small quarry.....	Local supply	....	....
10—	Small hill........	Local	½ East.......	....
10—	Small hill........	30,000±	1½ South.....	....

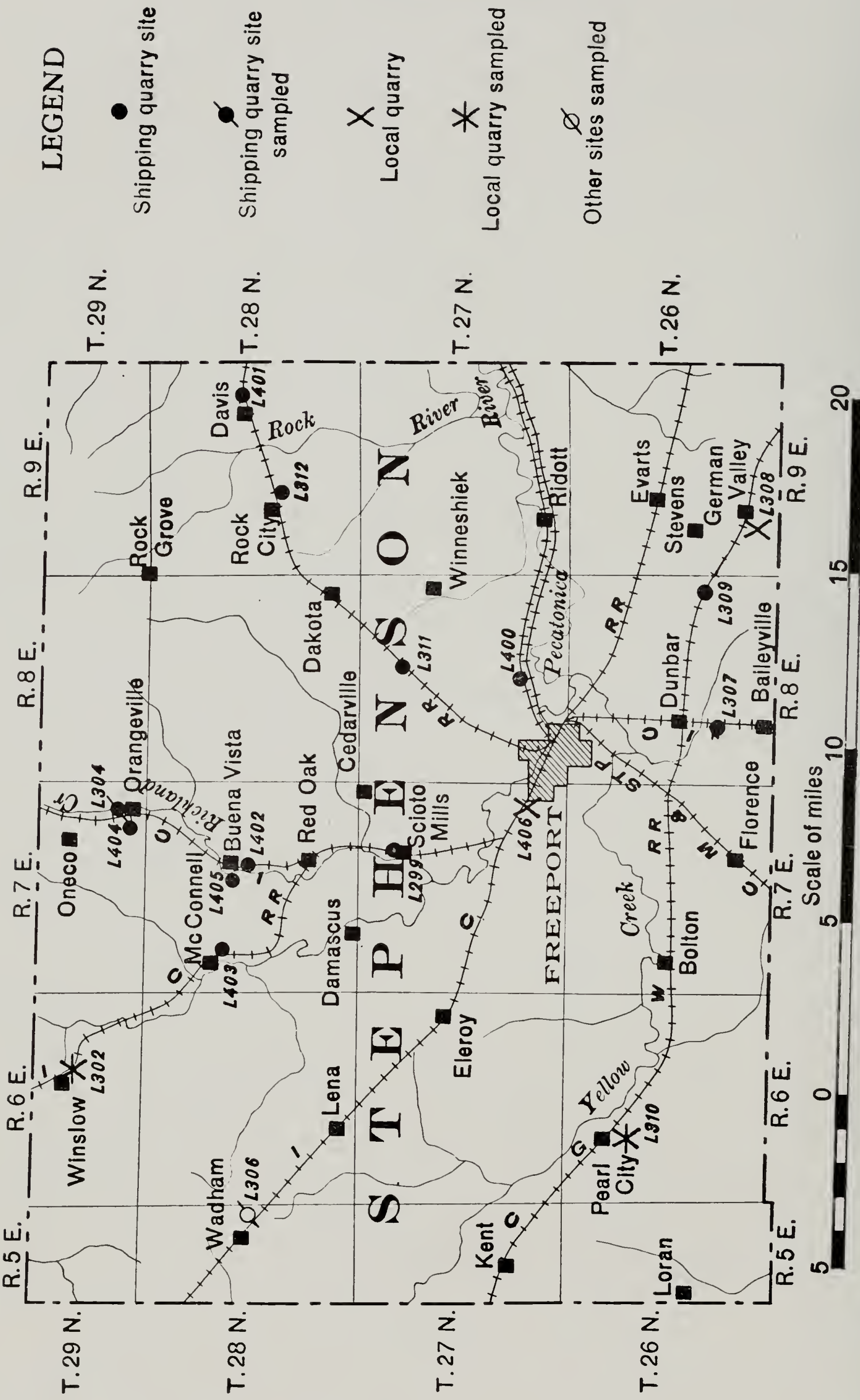

FIG. 34. Map of Stephenson County showing location of quarries and quarry sites.

STEPHENSON COUNTY

DESCRIPTION OF ROCK FORMATIONS

The bed rock of Stephenson County (fig. 34) is of Silurian or Ordovician age, and consists of Niagaran dolomite, Maquoketa shale, Galena dolomite and Platteville limestone.

The Niagaran dolomite.—The Niagaran dolomite is the cap rock of the large ridge extending southeast from Wadham for about 2½ miles. The formation is a doubtful source of any very great amount of road material because of its relative thinness and limited areal extent. The character of the rock is somewhat variable but in general it consists of a coarse-grained, coarsely crystalline, moderately hard to hard, buff-gray dolomite in beds averaging between 8 to 10 inches. As observed in this county, it has a middle layer of thin-bedded, shaly, rather soft dolomite which is probably of no great value as road metal.

The Maquoketa shale.—The Maquoketa shale comprises the major portion of the ridge extending southeast from Wadham and in addition probably underlies the greater part of the area southwest of the Illinois Central Railroad track northwest of Eleroy, and west of a north-south line through Eleroy. The rock is a dense, fine-grained, soft, gray-buff, compact shale. It pulverizes easily and is of doubtful value as road material, though it is used locally to some extent.

The Galena dolomite.—The Galena dolomite constitutes the bed rock over more than half the county. Most of the quarriable stone is to be found in this formation. From it the quarries about Freeport derived their product, when they were active. Numerous smaller openings in it are at present the source of a local supply of road and agricultural stone. The formation has apparently been subjected to considerable weathering even before the present exposures were made and shows as a result, decayed portions along the joint and bedding planes as well as small cavities partially filled with a porous mass of iron-stained dolomite crystals. Where weathering has been less active the rock occurs as precipitous slopes, and is heavy-bedded. The bedding of the Galena may vary from 1 inch to 5 feet, but most of the beds are between 8 and 10 inches thick. The dolomite is coarse-grained, coarsely crystalline, moderately hard, and generally gray or buff-gray where fresh.

The Platteville limestone.—The outcrops of Platteville limestone are found along Rock Run and its tributaries from Rock Grove, south to the junction with the Pecatonica River, and from this point west for about 6 miles along the latter stream. The limestone occurs in thin beds, averaging about 2 inches in thickness. The stone is a buff, fine-grained, earthy, moderately hard, magnesian limestone, or a blue, fine-grained, finely crystalline, hard, brittle, magnesian limestone.

SHIPPING QUARRIES

There are at present no shipping quarries in this county.

SITES FOR SHIPPING QUARRIES

L No. 299

Cen. SW. ¼ SE. ¼ sec. 2, T. 27 N., R. 7 E.

About one-fourth of a mile northeast of Scioto Mills a small idle quarry exposes 13 feet of moderately hard, coarse-grained, gray Galena dolomite. The dolomite averages about 27 feet in thickness, in a hill about 8 acres in extent, which has a content of about 350,000 cubic yards of stone, with overburden averaging less than 10 feet. A very large amount of stone could be obtained by quarrying below the level of the base of the hill.

The Illinois Central Railroad is about 1,800 feet to the west of this site. A switch is possible.

L No. 304

SW. ¼ SW. ¼ NE. ¼ sec. 36, T. 29 N., R. 7 E.

The village of Orangeville has opened a small quarry in the south end of a hill of Platteville limestone. The rock is a thin-bedded, rather soft, buff, earthy stone and has an exposed thickness of 29 feet. The hill is about 20 acres in extent with an average overburden of probably not more than 6 to 10 feet. The rock contents of the hill is somewhat less than a million cubic yards.

Topographic conditions do not favor a switch from the present quarry to the Illinois Central Railroad about a quarter of a mile west, but a little exploration work on the north and west sides of the hill might lead to the selection of a site suitable for quarrying and of more easy access to the railroad.

L No. 307

Cen. S. ½ NE. ¼ sec. 29, T. 26 N., R. 8 E.

Approximately 1½ miles north of Baileyville a good quarry site is afforded by a tract, comprising about 25 acres with less than 5 feet overburden and with at least 28 feet of rock. The track lies between the Illinois Central Railroad and a small bluff-bordered creek to the west. The rock is hard, tough, blue-gray, and in layers averaging about 8 inches in thickness. The inferred rock content of the site is somewhat over a million cubic yards.

The railroad runs on a small embankment so that special provisions would be necessary for the construction of a siding.

L No. 309

Cen. NE. ¼ SW. ¼ sec. 24, T. 26 N., R. 8 E.

About 3 miles north of German Valley, 30 to 40 feet of stone, with overburden averaging between 10 and 15 feet is exposed in a hill about 20 acres in extent. The rock is hard, fairly tough, buff-gray, Galena dolomite, in beds averaging 9 inches in thickness.

The Chicago Great Western Railroad runs on an embankment about 600 feet to the south. Special consideration would have to be given to the problem of locating a siding, since the topography is not favorable.

L No. 311

NE. ¼ sec. 10, T. 27 N., R. 8 E.

For a distance of approximately about 1000 feet along the Chicago, Milwaukee, and St. Paul Railroad, an average of 27 feet of Galena dolomite is exposed in a cut through a hill. The rock is a coarse-grained, moderately hard, gray-buff stone, rather porous in places and in beds averaging 10 inches. The hill in which this cut occurs is about 13 acres in extent and contains about 500,000 cubic yards of stone above the level of the railroad tracks, with less than an average of 10 feet of overburden. The railroad cut at present will not accommodate a switch, but a little excavation at the ends of the cut will allow sufficient space for one without great difficulty.

L No. 312

SW. ¼ SW. ¼ NW. ¼ sec. 22, T. 28 N., R. 9 E.

About five-eighths of a mile east of Rock City an unused quarry exposes 22 feet of moderately hard, gray-buff Galena dolomite in 12-inch beds. The opening has been made in the north end of a hill about 15 acres in extent, with an average thickness of about 36 feet of stone, and an average overburden of less than 10 feet. The inferred amount of rock available in this hill is approximately 1,000,000 cubic yards.

The Chicago, Milwaukee, and St. Paul Railroad is 750 feet to the north and at a somewhat greater elevation than the quarry. This makes a switch more feasible a little to the east where the topographic conditions are more favorable.

L No. 400

SW. ¼ sec. 27 and SE. ¼ sec. 28, T. 27 N., R. 8 E.

An outcrop of Galena dolomite in the road 2 miles east of Freeport exposes a total thickness of about 40 feet of stone for about 2,000 feet. Definite information is not available, but the hill is a large one and would probably furnish over 500,000 cubic yards of stone. The thickness of the overburden is uncertain but it is probably less than 20 feet.

The right-of-way of the Chicago and Northwestern Railroad is 600 feet to the south, and is so situated topographically as to permit the construction of a siding.

L No. 401

SE. ¼ sec. 13, T. 28 N., R. 9 E.

Along the Chicago and Northwestern Railroad about one-quarter of a mile east of Davis, is a large hill about 15 acres in extent, at one end of which is exposed 41 feet of Galena dolomite. Of this thickness, 26 feet is below the level of the railroad and 15 feet above. The stone is of fair quality and almost 700,000 cubic yards is probably available.

L No. 402

Cen. N. ½, west line sec. 23, T. 28 N., R. 7 E.

In a large hill three-fourths of a mile south of Buena Vista, about 75 feet of Galena dolomite of fair quality is exposed in a road cut. More than 500,000 cubic yards is probably available with less than 10 feet of overburden. The Illinois Central Railroad is about 900 feet to the west.

L No. 403

NW. ¼ sec. 17, T. 28 N., R. 7 E.

In the section five-eighths of a mile southeast of McConnell, there is an exposure of 20 to 55 feet of Galena dolomite in an irregular bluff which extends for about 2,200 feet along the northeast side of the Illinois Central tracks. This is a good site and an immense amount of stone is available with less than 5 feet of overburden.

L No. 404

SW. ¼ sec. 35, T. 29 N., R. 7 E.

A moderately large amount of the thin-bedded, argillaceous, Platteville limestone forms a bluff along a small creek one-half a mile west of Orangeville. The overburden is less than 10 feet on the average. The Illinois Central Railroad right-of-way is 2,500 feet to the north.

L No. 405

SW. ¼ SW. ¼ SW. ¼ sec. 10, T. 28 N., R. 7 E.

A small quarry here exposes 7 feet of Galena; 30 acres are reported to have less than 3 feet of overburden and the dolomite is recorded for a depth of 200 feet in water wells. The Illinois Central Railroad is half a mile east, down grade. A switch is topographically possible.

LOCAL QUARRIES

L No. 406

Cen. SW. ¼ SE. ¼ sec. 25, T. 27 N., R. 7 E.

On the northwestern outskirts of Freeport, there is a series of quarries in the Galena dolomite. None of these quarries is in operation nor do any appear to have been for some time.

The middle of the three quarries is equipped with an Austin Gyratory Crusher No. 5, one rotary screen (14 by 4 feet) with perforations ½, ¾, and 2 inches, and a bin, the estimated capacity of which is about 110 cubic yards. Under normal conditions of operation the output should be about 100 yards daily. The plant is apparently in a good state of repair and could probably be put into operation in a relatively short time. The bins and machinery are about 400 feet from the Illinois Central switch yards and apparently there have been switching facilities at some time, though none exist at present.

The primary difficulty encountered at this site is the lack of room for expansion. The quarry is hemmed in by streets and dwellings so that there remain only about two acres, containing approximately 250,000 cubic yards of stone, with less than 15 feet of overburden still available. Two industrial plants in proximity to the quarries would prevent heavy blasting and an extensive development of this site is not to be expected. It will, however, furnish a very desirable source of a considerable amount of stone for local consumption.

The southernmost of the three quarries noted is also equipped for crushing. The equipment consists of a Universal crusher (jaw, 12 by 18 inches), a rotary screen (6 by 4 feet) with perforations ¼ and ¾ inches, and a bin having a capacity of about 60 yards. The same restrictions for further development are imposed on it as on the above quarry, except that here the quarry must be deepened, as lateral expansion is impossible. The quarry is dry and undoubtedly could be deepened 20 or 30 feet before a serious amount of water, if any, were encountered. This location will furnish a valuable local supply.

L No. 302

SE. ¼ NW. ¼ SE. ¼ sec. 22, T. 29 N., R. 6 E.

The village of Winslow operates a quarry at this location for a local supply of stone for road purposes. The opening is made in the Platteville dolomite which has an exposed thickness of 41 feet, and consists largely of a blue or gray stone, hard or moderately hard, in beds averaging about 8 inches. An earthy, medial layer, 11 feet thick, is of a quality inferior to the rest of the exposure.

An Aurora Rock crusher No. 1 and a slat screen constitute the crushing apparatus.

A road and dwellings confine the quarry to a small lateral extension. The total amount of stone available without deepening is about 17,000 cubic yards.

L No. 308

Cen. SE. ¼ NE. ¼ sec. 31, T. 26 N., R. 9 E.

The township operates a small quarry 1¼ miles southwest of German Valley. The rock quarried is the Galena dolomite of which 21 feet is exposed. It is a moderately hard stone in beds averaging about 9 inches in thickness and improving in quality toward the bottom of the quarry. The outcrop occurs in one end of a long, oval hill, which will furnish a great amount of rock with probably less than 10 feet of overburden. At the quarry the overburden which is a black soil is about three feet thick.

The crushing machinery consists of an Altman Manufacturing Company crusher, with a 12- by 18-inch jaw.

L No. 310

SE. ¼ SE. ¼ SE. ¼ sec. 8, T. 26 N., R. 6 E.

The township operates at intervals a small quarry 1 mile south of Pearl City to provide a local supply of road stone. The opening exposes 44 feet of Maquoketa shale which is dense, soft, friable, and heavy-bedded, but weathers rapidly to thin slabs about 1 inch thick.

The crushing equipment consists of an Aurora Rock crusher (jaw, 6 by 12 inches) and a flat screen with ¼- and ½-inch mesh.

QUARRY SITES OF LOCAL IMPORTANCE

Quarry sites of local importance are in relatively great abundance in this county, especially in the northern part where the stream dissection is quite marked. In describing these sites no effort will be made to go into detail regarding all the possible sites for local quarries. A few of the better and more typical of such will be described in detail, and the remainder tabulated with the most important details, irregularities, or differences of each indicated.

SW. ¼ NW. ¼ NW. ¼ sec. 26, T. 28 N., R. 7 E.

This site consists of an outcrop of 13 feet of Galena dolomite in a hill covering about 7 acres, extending to the northeast from the exposure which occurs in a small quarry. Above the top of the exposed rock the hill rises about 28 feet, so that the total available thickness of stone is almost 40 feet. The overburden is probably about 6 feet thick on the average. About 400,000 cubic yards of stone is available. The Illinois Central Railroad is about 2,000 feet west from the exposure and at a considerable lower elevation.

Cen. NE. ¼ sec. 15, T. 28 N., R. 7 E.

This outcrop occurs in a cut made by the Illinois Central Railroad through a small hill along the right-of-way near Buena Vista. The maximum exposed face of rock is 32 feet and the average thickness throughout the hill about 20 feet. The hill will furnish an ample local supply of rock with less than 6 feet of overburden.

S. ½ SW. ¼ SW. ¼ sec. 14, T. 27 N., R. 6 E.

An old quarry at this location in the top of a hill exposes 18 feet of Maquoketa shale. The hill is about 40 feet high and 6 acres in extent, and might furnish about 300,000 cubic yards of stone. The stone is a soft, earthy, slabby rock, and is not good road material, although it is used locally.

SW. ¼ SW. ¼ SW. ¼ sec. 28, T. 28 N., R. 6 E.

At this location, three abandoned quarries present a general similarity of exposure of interbedded dolomite and shale. The dolomite is a dense, hard, tough stone and shows a maximum thickness of 16 feet. Any of these quarries will furnish an ample local supply, although for a very large supply the quarry to the northwest of the road and railroad is recommended as having the most favorable situation. There is a possibility of opening a shipping quarry at this site. About 700,000 cubic yards of stone is available. The difficulties, however, lie in the interbedding of the shale and limestone, in the possibility of an overburden as much as 25 feet in thickness, and the not especially favorable topographic conditions for a siding.

L No. 306

SW. ¼ SE. ¼ SE. ¼ sec. 13, T. 28 N., R. 5 E.

This site consists of a small quarry opened at the top of a large hill which is capped by 22 feet of Niagaran dolomite. The major portion of the hill is of Maquoketa shale. The Niagaran as here exposed consists of a coarse-grained, moderately hard, rather tough stone, with a medial layer of soft, argillaceous stone. By expanding in this cap rock on the top of the hill, a supply of stone ample for local purposes, is easily accessible. The overburden is small, probably not in excess of 4 feet at any place.

SW. ¼ SE. ¼ SE. ¼ sec. 1, T. 26 N., R. 7 E.

This is the site of an abandoned quarry formerly the source of road and dimension stone. The rock is the Galena dolomite of which 35 feet is exposed. Some of the more available rock has been removed, but there still remains about 100,000 cubic yards of stone which may be obtained with less than 10 feet of overburden, and of this total about 30,000 cubic yards might be obtained by deepening the present quarry about 15 feet.

TABLE 11.—*List of additional outcrops*

Town-ship N.	Range E.	Section	Part of section	Formation	Thickness	
					Rock	Over-burden
					Feet	*Feet*
26	5	15	Center S. line.........	Maquoketa....	Small	5—
26	5	15	NW. NW. SE.........	Maquoketa....	Small	5—
26	5	22	Center E. ½..........	Maquoketa....	Small	5—
26	6	8	Center SW.	Maquoketa....	35	Small
26	6	13	Middle W. line NW. ¼	Galena........	28	75—
26	6	13	W. ½	....	....	....
26	6	14	E. ½	Maquoketa....	55	10—
26	7	11	Middle N. line........	Galena........	12	5—
26	7	17	Center NW.	Galena........	6	4—
26	7	23	SW. NW.	Galena........	Small	Small
26	7	23	NE. SW.	Galena........	Small	Small
26	9	4	SE. SW.	Galena........	51	5—
27	6	1	NW. SW.	Galena........	....	10—
27	6	1	SW. SE. SE...........	Galena........	35	10—
27	7	3	Middle S. line SE. ¼..	Galena........	9	Small
27	7	5	Middle W. line........	Galena........	....	5—
27	7	5	Middle S. line SE. ¼..	Galena........	....	5—
27	7	11	SE. SW.	Galena........	8	Small
27	7	17	SW. SW. SW.........	Galena........	10	5—
27	7	17	NE.	Galena........	105	7—
27	8	22	SE. SE. SE...........	Galena........	7	6—
27	8	24	Middle E. line.........	Platteville.....	10	5—
27	8	2	NE. NE.	Galena........	8	5—
27	8	5	NW. NW.	Galena........	15	5—
27	8	11	NE. SE. SE...........	Galena?.......	9	5—
27	9	9	NE.	Platteville.....	35	3—
27	9	28	NW.	Galena........	15	5—
28	7	17	Center N. line and S. ½.	Galena........	10	5—
28	7	35	Center N. line........	Galena........	60	10—
28	8	11	N. ½	Galena........	14	5—
28	8	16	SE.	Galena........	5	3—
28	8	25	Center S. ½..........	Galena........	13	5—
28	9	23	Middle W. line........	Platteville.....	17	5—
28	9	34	NE. NE.	Platteville.....	....	5—
29	6	23	Middle E. line.........	Platteville.....	....	5—
29	8	23	NW. SE.	Galena........	11	5—

where rock has been quarried in Stephenson County

Location of exposure	Supply available with overburden indicated	Distance to railroad	Remarks
		Miles	
Hillside	Local	4 Northeast	
Hillside	Local	3½ Northeast	
Hillside	Local	4½ Northeast	
Hillside	Local	½ Northeast	
Bluff of Yellow Creek	Ample local	¾ South	
Bluff of Yellow Creek	Large	⅜ South	
Hill	Ample local	2 South	
Creek bank	Local	¾ South	
Hill	Local	1⅛ Southeast	
Hill	Local	¾ Southeast	
Hill	Large	1¾ North or South	Stone badly weathered
Valley side	Local	1¼	
In hill	Local	1¼ Southeast	
Hill	Local	1¼ East	
Hill	Local	3 East	
Hill	Local	2¼ East	
Hill	Large amount	⅜ West	
Valley side	Local	1/16 Southwest	
Large hill	Immense amount	1 Southwest	Possibly fair shipping site; 2 quarries
Hill	Local	⅝ Southwest	
Hill	Local	1¾ Southwest	
Hill	Local	0	
Hill	Local	3 East	
Hill	Local	1½ Northwest	
In road	Local	4 Northwest	In road bordering NE. ¼
In valley side	Local	1 South	
Hill	Local	⅜	2 quarries
Large hill	Large amount	½ East	Possibly fair shipping site
Hillside	Ample local	4 Southeast	Along road (2 quarries)
Hilltop	Local	4½ Southeast	
Hill	Ample local	¼ Southeast	In town of Dakota
Valley side	Ample local	½ North	
Hillside	Local	2 Northwest	
Hill	Local	¾ Southwest	
Valley side	Ample local	5¼ West	

TABLE 12.—*List of undeveloped outcrops*

Township N.	Range E.	Section	Part of section	Formation	Thickness	
					Rock	Overburden
					Feet	*Feet*
27	9	6	E. ½, south line	Platteville	....	5—
28	6	1	SW. ¼	Galena	50	10—
28	6	12	Cen. and SE. pts	Galena	40±	10—
28	7	13	NE. ¼ SE. ¼ SE. ¼	Galena	50	5—
28	7	21	SE. ¼ SW. ¼ SW. ¼	Galena	....	Small
28	7	33	SW. ¼	Galena	42	Small
28	7	36	NE. ¼	Galena	50	10—
28	8	31	E. ½	Galena	5—	Creek
28	9	15	E. ½	Platteville	22	7—
28	9	20	SE. ¼	Platteville	5	....
28	9	22	NE. ¼	Platteville	32	10—
28	9	27	N. ½	Platteville	30	Rather heavy
28	9	30	SE. ¼ SE. ¼ SE. ¼	Galena	40	Small
28	9	35	SE. ¼ NW. ¼	Platteville	18	5—
29	7	19	NE. ¼	Galena	....	5—
29	8	36	E. ½ NW. ¼	Galena	30±	10—
29	9	27	Center	Galena	....	Small
29	9	29	NE. ¼	Galena	....	5—

along roads or creeks in Stephenson County

Location of exposure	Supply available with overburden indicated	Distance to railroad	Remarks
		Miles	
Large hill	Ample local	2 Northwest	Road cut
Bluff of creek	Large	¾ East	
Large hill	Immense	¾ East	Road cut
Large hill	Ample local	1¾ Southwest	Road cut
Railroad cut	Local	0	
Bluff Pecatonica River	Very large	2¼ East	
Bluff of creek	Very large	2 East	
Creek bluff	Local	2¼ West	
Bluff, Rock Run	Large	¾ Southeast	
	Local	0	Railroad cut and road
Bluff, Rock Run	Ample local	0	Rock largely below railroad level; poorly situated
Creek bluff	Ample local	¾	
Big hill	Ample local	1 Northwest	Road cut
Bluff, Rock Run	Ample local	2¼ Northeast	
Large hills	Large	3 Southwest	In road
Large hills	Large	6 West	In road
Hills	Large	3¼ Southeast	In road
In road	Local	4½ Southeast	

WHITESIDE COUNTY

DESCRIPTION OF FORMATIONS

Most of Whiteside County (fig. 6, p. 94) is drift covered and rock exposures are therefore confined largely to stream valleys. The geologic formations which outcrop in the county and are usable as road metal are the Niagaran and Galena-Platteville dolomites.

The Galena-Platteville formation is confined to the northeast corner of the county where limited exposures occur on Buffalo Creek near Stanfordsville, and near the county line or just across it on Elkhorn Creek.

The Niagaran dolomite is the most widespread bed-rock of the county, underlying the glacial drift and loess for about five-sixths of the total area. It is commonly a buff, gray or white dolomite, locally crystalline, or porous and is generally cavernous. On extreme weathering the dolomite changes to a rust-yellow and becomes very porous and crumbly.

The most extensive exposures of the Niagaran dolomite occur in the bluffs in the W. ½ of T. 22 N., R. 4 E., between Cat Tail Slough and the north county line. In secs. 19 and 20 the bluff is low and, particularly in sec. 20, is composed largely of sand. In the NW. ¼ of sec. 19 (L No. 10), however, there are several partly disconnected rock noses about 20 to 30 feet high with little or no overburden. The cut-off of the Chicago, Milwaukee and St. Paul Railway is about 1500 feet to the west. This site might possibly be developed into a shipping quarry if a little care is exercised in locating the quarry so as to take advantage of the largest of the rock noses with a minimum of overburden.

In sec. 18, T. 22 N., R. 4 E., the bluff is low and broken by many ravines and valleys. In places 20 to 30 feet of dolomite are exposed, but the overburden composed of very fine sand is heavy, probably 30 feet or more.

In sec. 8, T. 22 N., R. 4 E. the character of the bluff changes and particularly in the S. ½ of the section a shear face of rock 60 to 80 feet high is exposed. At the top of the bluff there is a limited area 25 to 50 feet wide where the overburden is not great, but farther back from the edge of the bluff the thickness of the overburden increases to 50 feet or more and probably prohibits profitable quarrying. There is probably also very little chance to deepen a quarry at this site because of the occurrence of the Maquoketa shale in the lower portion of the bluff. The Maquoketa formation is not exposed, but the character of the topography and a persistent zone where springs are common suggest its presence. The Chicago, Milwaukee and St. Paul Railway about 2½ miles to the west across the valley flat is the nearest railroad.

In sec. 5, T. 22 N., R. 4 E. the bluff and conditions of overburden, rock and transportation are about the same as those in sec. 8, except that the bluff is more dissected by streams and presents a broken profile which gradually lowers to the north.

Another extensive exposure of the Niagaran dolomite occurs in four abandoned quarries, in the northwest corner of the town of Fulton and in a badly slumped bluff just north of the town in the SW. ¼ sec. 21, T. 22 N., R. 3 E. along the Chicago, Milwaukee and St. Paul Railway. The quarries have faces of rock varying from 25 to 40 feet in height but have apparently been abandoned because of an excessive amount of overburden. The overburden consists of very fine sand intermixed with some clayey material and varies from 20 to 30 feet in thickness as exposed in the quarries, but rises rapidly back from the quarry faces to a thickness of 35 to 60 feet.

The bluff along the railroad shows 40 to 70 feet of Niagaran dolomite in places, but like the quarries has a heavy capping of overburden which rises above the rock without marked interruption of slope.

None of the quarries is over 700 feet from the railroad and the bluffs mentioned occur along the railroad cut. Transportation is easy to obtain, therefore. There is sufficient rock to make a good quarry face, but the heavy overburden rather condemns this site for development of large quarries.

Other outcrops of Niagaran dolomite which were observed in Whiteside County are as follows:

1. On the northeast outskirts of Albany and also about a mile east of the town, is an exposure of 10 to 20 feet of badly weathered dolomite overlain by heavy overburden.

2. An abandoned quarry north of Morrison at the center of the south line of sec. 6, T. 21 N., R. 3 E. exposes 10 to 20 feet of badly weathered dolomite with heavy overburden.

3. In the west valley slope of the Cat Tail Creek abandoned quarries and small outcrops occur in the W. ½ sec. 36, T. 22 N., R. 3 E.; in the N. ½ and W. ½ sec. 12, and in the NW. ¼ sec. 18, T. 21 N., R. 3 E.

4. In the S. ½ sec. 11 and W. ½ sec 14, T. 22 N., R. 4 E. and on the east edge of Sterling along the north side of the Chicago and Northwestern Railway tracks, outcrops may be found.

5. One exposure of limestone, probably of Maquoketa age occurs just west of the center of the north line sec. 21, T. 20 N., R. 3 E., where 6 feet of thin-bedded limestone capped with about 25 feet of sand and loess are exposed.

SHIPPING QUARRIES

There are no shipping quarries in Whiteside County.

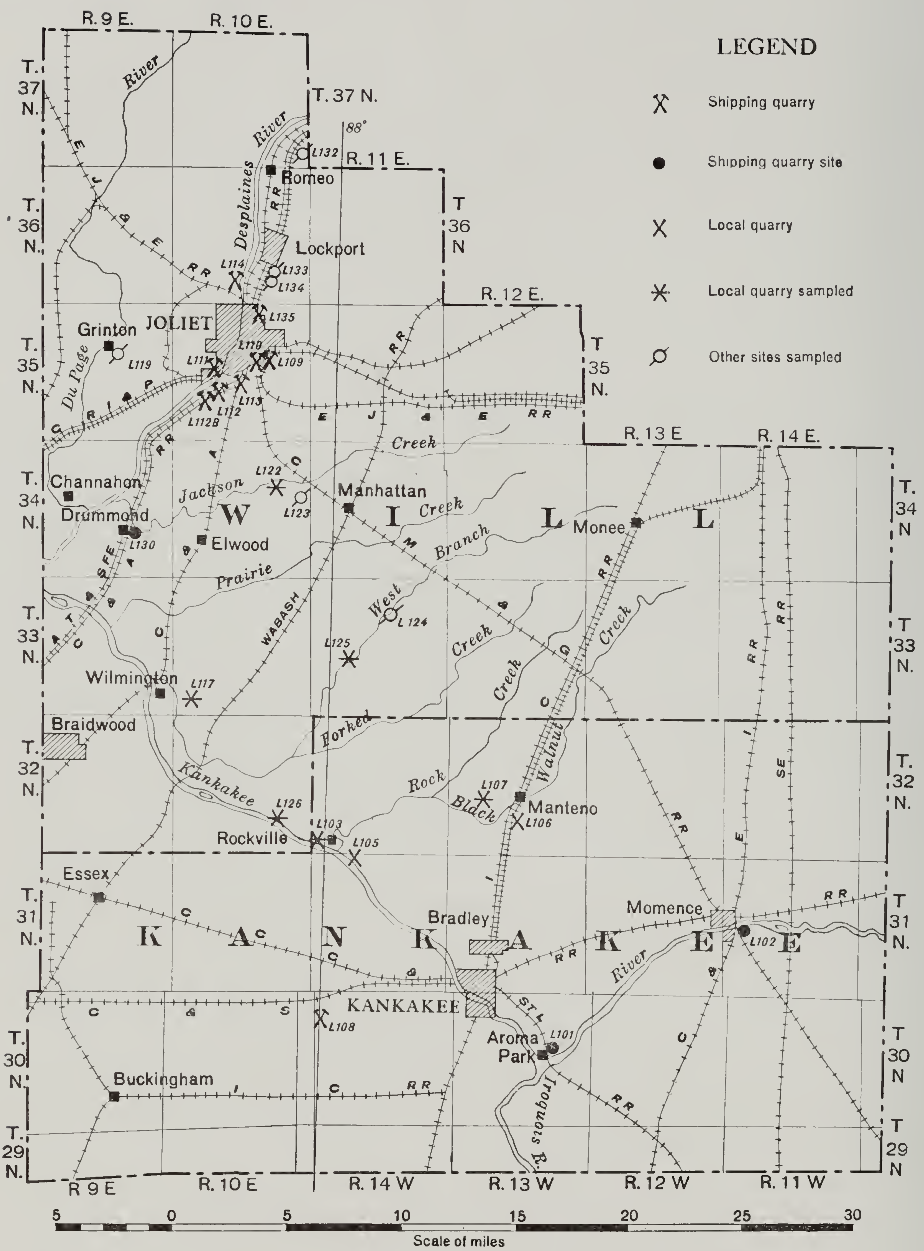

FIG. 35. Map of Will and Kankakee counties showing location of quarries and quarry sites.

SHIPPING QUARRY SITES

The best location for a shipping quarry would probably be in the Mississippi River bluff north of Fulton. The rock available is the Niagaran dolomite. In most places the overburden is rather heavy and consists of glacial drift and loess. Transportation may be secured by the Chicago, Burlington and Quincy and the Chicago, Milwaukee and St. Paul railways located in the flood plain of the river about two miles to the west. A detailed study of the bluff area may reveal places where the overburden is comparatively thin and where shipping quarry sites might be located. The distance of the bluff from the railroads and the heavy overburden are perhaps the most inhibitive factors to commercial quarrying.

LOCAL SUPPLIES OF STONE

The Mississippi River bluff and other localities previously mentioned will furnish ample supplies of stone for local use.

WILL COUNTY

Limestone suitable for road material underlies almost the entire extent of Will County (fig. 35) except the southwest corner, where Pennsylvanian shales and sandstones and Maquoketa shales and shaly limestones comprise the bed rock.

The limestone is of Silurian age and is mainly Niagaran, though the lower beds probably belong to the Alexandrian series. The character of the stone varies somewhat both vertically and horizontally, but in general the Niagaran is a buff to gray, compact, slightly porous, hard and brittle dolomite. The upper beds are thin-bedded and somewhat cherty, while the lower beds are more massive and are usually free from chert.

Over much of Will County, especially in the eastern and northeastern parts the bed rock is buried under such a great thickness of drift as to make the limestone unavailable, but in the western part of the county where the streams have removed much of the overlying drift, rock outcrops are numerous.

Eight quarries in the county have shipping facilities and all of them are located in the vicinity of Joliet. Four of the quarries produce crushed stone for road material and aggregate, one produces only building stone, another rubble and riprap, and two are idle.

SHIPPING QUARRIES

L No. 113

National Stone Company

The property of the National Stone Company embraces about 30 acres located about one mile south of Joliet, in the NE. ¼ SE. ¼ sec. 21, T. 35 N., R. 10 E., and contains the largest quarry in Will County. The production varies from 1,200 to 1,500 tons of crushed stone daily.

The quarry, roughly oval in outline, is located on almost level ground and is worked as a pit. Its longest diameter is about 600 feet and the shortest about 450 feet. The main quarry face is about 40 feet high, but another face about 45 feet high has been developed in the center of the quarry by deepening.

About 90 feet of rock is exposed in the quarry. The rock is reported to be about 120 feet thick. A section is as follows:

	Thickness *Feet*
2. Dolomite, thin-bedded, fine-grained, somewhat porous, buff to white, in layers 1 to 14 inches, containing thin nodules and layers of chert..	43
1. Dolomite, compact, blue-gray, beds 18 inches or more in thickness, and free from chert..	45

The overburden consists mainly of black and brown loam having an average thickness of about 2½ feet. The overburden is scraped back from the face into piles. The quarry water is taken care of by an 8-inch centrifugal pump.

In quarrying, 6-inch holes are put down with churn drills to the full depth of the face. The holes are spaced about 8 feet apart and are loaded with 40 per cent dynamite. The broken rock is loaded into 4-yard cars by means of a Bucyrus 70-ton and a Marion 50-ton steam shovel. The loaded cars, eight to a train, are pulled to the tipple by locomotives; here a cable is attached, and the cars are drawn up to the crushers and automatically dumped.

The crushing machinery consists of four Worthington gyratory crushers, Nos. 5, 6, 8, and 17. Worthington screens are used to separate the crushed rock into different sizes. Any size up to 5 inches can be produced.

Storage room is afforded by bins having a total capacity of eight carloads, or about 400 tons, and by ground space in the yard. A crane with a clamshell bucket is used in loading from the storage piles for shipment.

The product is used for railroad ballast, aggregate, road material, and agricultural limestone.

Transportation is provided by a switch to the Chicago and Alton Railroad.

L No. 135

Joliet Penitentiary

The quarry of the Joliet Penitentiary is located in a bench of the Des Plaines River bluff, in the SW. ¼ NE. ¼ sec. 3, T. 35 N., R. 10 E. Sixty acres of rock is held in reserve, but the change in location of the Penitentiary from the present site to the other side of the river may cause abandonment of the present site.

The quarry is a roughly triangular pit, the longest side about 1,000 feet in length, and the shorter sides about 500 and 700 feet, respectively.

The 38 feet of rock exposed is thin-bedded, fine-grained, buff to gray dolomite, with thin layers and nodules of chert. The total thickness of the rock is probably more than 100 feet. The overburden consists of black loam and averages about 2 feet in thickness. Quarry water is removed by a centrifugal pump.

The plant has a daily capacity of 750 yards, but the average production is about 150 yards.

A 38-foot face of rock is worked. The blast holes are drilled with an 8-inch churn drill and sprung with 40 per cent dynamite.

The broken rock is hand loaded into 1½-ton or 3-ton cars and pushed to the tipple where the cars are drawn up by cable and the rock automatically dumped into the crushers. Four Austin gyratory crushers, Nos. 3½, 5, 7½, and 10, reduce the stone to the sizes desired. Three sizes are obtained from dust to ⅜ inch, ⅜ to ¾ inch, and ¾- to 2-inches. Of these sizes, the ⅜-inch material makes up about 18 per cent of the original rock, the ¾-inch material about 32 per cent, and the 2-inch stone makes up the remainder. Two screens, 3½ by 15 feet, and one 5 by 15 feet, are employed in separating the stone into the different sizes.

The product is used mainly for aggregate and road material. The aggregate is used largely at other State institutions, and road material by townships in the vicinity.

Transportation is furnished by the Elgin, Joliet and Eastern Railway.

L No. 111

Markgraf Stone Company

The quarry of the Markgraf Stone Company is located in the SE. ¼ SE. ¼ sec. 17, T. 35 N., R. 10 E., west of Des Plaines River and near the outskirts of Joliet. Transportation is furnished by the Chicago, Rock Island and Pacific Railway.

At the present stage of development, the quarry is a pit nearly square in outline and about two acres in extent. The height of the quarry face is about 45 feet. Drainage is provided by means of a 6-inch centrifugal pump. The overburden consists of only about 9 inches of black loam which is removed by hand loading into trucks.

The upper 35 feet of rock exposed in the quarry is a fine-grained, somewhat porous, thin-bedded and slightly cherty, buff to gray dolomite. Thin partings of shale separate the beds in places. The lower 8 feet of rock is somewhat coarser-grained, lacks the shale partings, and consists of thicker beds. Three samples for testing were taken here, 111A and 111B from the upper 35 feet and 111C from the lower 8 feet.

The rock is quarried in 10-foot benches. Ingersoll Rand air drills are used to make the blast holes which are shot with 40 per cent dynamite.

The broken rock is loaded by steam shovels into 2-yard quarry cars which are pulled to the tipple by a locomotive. They are elevated to the crushers by a friction hoist and automatically dumped.

The crushing machinery consists of two gyratory crushers, a No. 8 and a No. 3 Telsmith. A McCully rotary screen 48 inches in diameter and 20 feet long is used to sort the rock into the desirable sizes.

Storage is provided by bins holding 400 yards and by a storage yard. The capacity of the plant is 800 tons daily. The daily production is about 500 tons and the yearly production about 125,000 tons. The crushed stone is used for railroad ballast, road material, and aggregate.

L No. 112

Lincoln Crushed Stone Company

The property of the Lincoln Crushed Stone Company includes about 19 acres in the SW. ¼ SE. ¼ sec. 20, T. 35 N., R. 10 E., about one mile south of Joliet. The quarry is located in the side of a low hill and covers about 10 acres.

The rock is a finely crystalline, buff to gray dolomite. It occurs in thin layers 1 to 13 inches thick, which are not uncommonly separated by thin partings of clay. Chert is found as thin layers and nodules. The overburden, a black and brown loam about 1½ feet thick, is removed by scrapers, steam shovel and auto trucks.

In quarrying, a 40-foot face is worked. Blast holes are made with a well drill and 40 per cent dynamite is used in shooting down the rock. Air jack-hammers are used to drill the holes for the smaller shots.

The broken rock is loaded by steam shovels into 3½-yard cars which are pulled to the tipple by locomotives and up the tipple by cable where they are automatically dumped into the crusher.

Four gyratory crushers, a No. 18 and No. 8 Allis-Chalmers, a No. 5 Gates and a No. 3 Allis-Chalmers are used in crushing the rock and two 60-inch Allis-Chalmers cylindrical screens are employed in separating it into the desired sizes.

Storage space is provided by bins having a total capacity of about 600 yards. The daily production is about 1800 tons, and the capacity of the plant about 2500 tons. The Chicago and Alton Railroad provides transportation.

The rock is sold for railroad ballast, aggregate, road and agricultural limestone.

L No. 112 B

Inland Crushed Stone Company

The property of the Inland Crushed Stone Company includes 20 acres to the west of the property of the Lincoln Crushed Stone Company. The quarry recently purchased by the present company from the Ideal Stone Company was not in operation at the time of this investigation. It is reported, however, that the quarry will be reopened after the necessary repairs and improvements have been made.

The quarry is worked as a rectangular pit, 700 feet long and 250 feet wide. Quarry practice and the method of handling the rock are practically the same as those employed at the Lincoln Crushed Stone Company (L No. 112). The crushers are four in number—Gates Nos. 8, 5, 4, and 3. One 4- by 24-foot screen is used to size the stone.

L No. 110

Western Stone Company

The property of the Western Stone Company includes about 100 acres in the NW. ¼ SE. ¼ sec. 15, T. 35 N., R. 10 E. at the southeast edge of Joliet.

The quarry has not been in operation since 1913, but the equipment and plant buildings appear to be intact. When in operation transportation was furnished by the Elgin, Joliet and Eastern, Michigan Central, and Chicago and Alton railroads.

The quarry which was worked as a pit, is roughly rectangular in outline, about 2,500 feet long and 800 feet wide, and has a face about 25 feet high. Most of the rock quarried for crushed stone has been obtained from an area about 1,000 feet long and 600 feet wide with a face about 45 feet high. Only about 25 feet is now exposed, however, for the deeper portions of the quarry are filled with water.

The rock is fine-grained, somewhat porous, white dolomite. The beds are thin and range in thickness from 3 to 10 inches. Thin partings of a greenish clay separate the different beds, and chert in thin layers and nodules is present but is not abundant. The rock is reported to become massive with increasing depth and the green clay partings are said to be lacking in the lower portion. Pyrite is common along the joint planes. The overburden, a gray or brown till, averages about 3 feet in thickness.

The face was worked in benches 20 feet high. Both well and tripod drills were used to drill the blast holes and 40 and 60 per cent dynamite was used in blasting.

The broken rock was loaded by steam shovels into 4-yard cars, which were hauled to the tipple by a locomotive. Three Gates gyratory crushers, Nos 5, 7½, and 12, were used for crushing and a set of rolls for pulverizing. Two sets of screens separated the crushed rock into sizes up to three inches.

The product was used mainly for railroad ballast, aggregate, and road material, but some rock for dimension stone, riprap, and rubble was also obtained.

L No. 114

Gross and McCowan Lumber Company
(Formerly the Commercial Stone Company)

The quarry of the Gross and McCowan Lumber Company is located on the side of a gently sloping hill in the SW. ¼ NE. ¼ sec. 33, T. 36 N., R. 10 E. about two miles north of Joliet.

The quarry is about 450 feet long, 300 feet wide, and 35 feet deep. It is worked in four 8-foot benches. A derrick is used to load the stone into railroad cars and trucks. The overburden varies from 6 to 11 feet, and is composed of sandy gravel containing numerous limestone cobbles.

A section of the rock making up the quarry is as follows:

	Thickness *Feet*
2. Dolomite, cherty, badly weathered, buff-colored, fine-grained.........	8
1. Dolomite, compact, finely crystalline, gray, in beds 3 to 30 inches; pyrite common along joint planes..............................	27

The entire output of the quarry is used for building stone, rubble, and riprap.

L No. 109

Swan, Medin and Company

The quarry of Swan, Medin and Company is located in the SE. ¼ sec. 15, T. 35 N., R. 10 E. about a quarter of a mile southeast of Joliet. It is operated only when there is a demand for building stone. There are no crushing facilities.

The quarry covers about eight acres and only the upper 10 feet of rock is being worked. The stone is a fine-grained, finely crystalline, hard, white dolomite in beds 6 to 30 inches thick. It contains very minute particles of pyrite and therefore changes to a buff color after exposure to the weather for a time. The overburden which consists of clay till with numerous dolomite boulders is from 6 to 12 feet thick, but averages about 8 feet.

Transportation is provided by the Michigan Central Railroad.

POSSIBLE SITES FOR ADDITIONAL SHIPPING QUARRIES

As a general statement, it may be said that all the best sites in the county are already occupied by shipping quarries and any additional ones would have to be located in the same general vicinity as are the present quarries. Unless the demand for crushed rock will be greater than can be supplied by existing quarries, new quarries would be at a disadvantage.

L No. 130

Probably the best site for a new quarry would be in the vicinity of Drummond in the SE. ¼ SE. ¼ sec. 22, T. 34 N., R. 9 E. At this locality there is a flat of at least 100 acres with less than a few feet of overburden, or about 300 acres with probably less than 5 feet.

As both the Santa Fe and the Chicago and Alton railroads run through Drummond station, at the west edge of the flat, transportation facilities may readily be obtained.

The rock as exposed in an abandoned quarry is a thin-bedded, finely crystalline, and somewhat porous dolomite. Films of green clay separate the different beds, and chert is present as thin layers and nodules. The rock may be expected to be massive at greater depths. Though a thickness of only 24 feet was worked in the old quarry, it is reported that the rock probably continues downward for more than 100 feet.

The amount of water that would have to be handled as well as the suitability of rock as road material is probably similar to that of the Joliet quarries.

LOCAL QUARRIES

Several outcrops in the county are used as a source of stone for local use. This is especially true in the regions that lack good railroad facilities.

L No. 122

Along the banks of Jackson Creek in the SE. ¼ NE. ¼ sec. 14, T. 34 N., R. 10 E., there are about 50 acres of land underlain by limestone with less than 5 feet of overburden.

The nearest railroad, the Chicago, Milwaukee and Gary is about one mile northeast of the deposit, and the Chicago and Alton lies about 3 miles west. The intervening surface is level or only slightly undulating.

The exposed rock is of Niagaran age, and is essentially a thin-bedded, finely crystalline and somewhat porous, buff dolomite. Chert layers and nodules are present locally. In places, layers of coarsely crystalline, pink dolomite are found interbedded with the buff fine-grained rock.

A section of the exposed rock is as follows:

	Thickness	
	Feet	*Inches*
3. Dolomite, fine-grained, buff in beds ½ to 3 inches thick. Local thin layers or nodules of chert	9	2
2. Dolomite, coarsely crystalline, in beds 3 to 8 inches thick. Pink in color, with streaks of green	4	4
1. Dolomite, fine-grained, buff like No. 3	3	2
Total	16	8

Though only about 17 feet of rock is exposed, wells drilled in the vicinity show the rock to be over 70 feet thick.

In years past stone for road material was quarried here by Jackson Township. A thickness of about 10 feet was quarried along a 300-foot strip. The quarry has been idle for two years but the crushing machinery, a Fort Wayne crusher (jaw 4 by 18 inches) and a small rotary screen with a bin are still in place.

L No. 126

Rock for use in local roads has been quarried in the bluff of Kankakee River in the center of sec. 26, T. 32 N., R. 10 E., by Wesley Township. Along the bluff an area of about 10 acres is available with less than 10 feet of overburden.

A thickness of about 11 feet of rock is exposed. The rock is medium-grained, crystalline dolomite; the upper 5½ feet consists of beds 1 to 4 inches thick, and white in color, while the lower 5½ feet consists of beds ranging from 6 to 10 inches in thickness and have a faintly pink color. They are probably of early Silurian age. Both beds were sampled but the lower 5½ feet, (Sample 126 B) was the only one tested.

The plant was not in operation at the time of visit but contains an Austin No. 3 crusher and a 24-inch cylindrical screen.

L No. 125

A small quarry is operated by Wilton Township in the SE. cor. sec. 20, T. 33 N., R. 11 E., to provide crushed rock for use on local roads. The quarry is situated in the flood plain of a creek and was filled with water at the time of investigation. No good exposure of stone was observed but the rock appears to be a hard, finely crystalline, gray dolomite. Probably about 5 acres is available with less than 5 feet of overburden.

A No. 3 Austin crusher, and a 24-inch screen are used to crush the stone.

L No. 117

A small quarry is operated in the banks of the creek in the NE. ¼ sec. 31, T. 33 N., R. 10 E. (fig. 36). A thickness of about 10 feet of rock, is exposed and an area of about 3 acres is available with less than 8 feet of overburden. The rock is a compact gray limestone in beds ranging in thickness from 2 to 6 inches. Thin films of blue clay separate the beds and streak the fresh surface. Sample L 117A was taken from the upper beds and L 117B from the lower.

An Austin No. 3 crusher and a 24-inch rotary screen make up the crushing plant.

OTHER LOCALITIES WHERE STONE FOR LOCAL USE MAY BE OBTAINED

The following localities in no way exhaust the list of limestone outcrops but serve mainly to show their general character.

L Nos. 132, 133, and 134

Desplaines River bluff

Along the east side of Desplaines River from the north line of the county southward to within about 1½ miles of Joliet, there is a pronounced bluff, broken at intervals by small creek valleys. The bluff has a steep or moderately steep face for a height of approximately 75 feet, but above this height the slope becomes gentle. Southward from Lockport the bluff shows a distinct bench 150 to 200 feet wide which appears to mark the top of the rock in this area. Rock ranging in thickness from 17 to 35 feet is exposed almost continuously along the foot of the bluff. The upper part of the

FIG. 36. Edgewood limestone as exposed at L-117 near Wilmington. (See fig. 35.)

bluff consists of clay till which reaches a thickness of 50 feet or more. As a result only a narrow strip of rock along the foot of the bluff is available without overburden prohibitive of profitable quarrying.

Though transportation might be obtained over the Chicago and Alton Railroad which runs along the foot of the bluff the limited amount of rock available at any one place discourages large-scale quarrying. In the vicinity of Lockport and southward, where most of the overburden has been removed for a distance of from 150 to 200 feet back from the edge of the bluff, the presence of a State road and numerous houses probably place the cost of the land beyond the limits generally allowed for quarry sites.

On the west side of the river the bluff is not so pronounced as on the east and the rock is generally obscured. There are a few outcrops which might be quarried but the absence of transportation facilities makes the use of the rock unprofitable except for local purposes.

FIG. 37. The waste heap along the Desplaines drainage canal near Lockport.

Spoil banks along Desplaines River

Large quantities of rock were excavated from Desplaines River when it was deepened to serve as a drainage canal for the Chicago district. This rock is now piled along the banks and where accessible can be used for road material if so desired (fig. 37).

The spoil banks begin about half a mile north of the bridge at Lockport and extend on both sides of the river as far north as Romeo. From Romeo to the county line the bank is found only on the west side. It is about 3 miles long, about 175 feet wide at its base, and about 65 feet high.

The rock is of Niagaran age and similar to that found in the quarries around Joliet.

SE. cor. sec. 2, T. 36 N., R. 9 E.

About 17 feet of Niagaran dolomite outcrops along the east bluff of Lilly Cache Creek in this region. About 5 acres with less than 10 feet of overburden are available. The deposit is 2½ miles north of the Elgin, Joliet, and Eastern Railway.

Other outcrops somewhat similar may be found along several of the creeks in this vicinity.

NW. ¼ sec. 15, T. 33 N., R. 9 E.

Along Prairie Creek near its junction with Kankakee River in SE. ¼ NW. ¼ sec. 15, T. 33 N., R. 9 E., there is an exposure of 11 feet of compact gray limestone of lower Silurian age. The rock is a hard, gray, moderately coarse-grained, dense, brittle limestone. Probably about 5 acres is available with less than 5 feet of overburden.

L No. 123

Eighteen feet of Niagaran dolomite is exposed in the SW. ¼ NW. ¼ sec. 13, T. 34 N., R. 10 E. About 20 acres is available with less than 5 feet of overburden. The Chicago, Milwaukee and Gary Railroad is 1 mile east of the property and the intervening region is gently rolling. Though only 18 feet of rock is exposed, it probably continues in depth for more than 100 feet.

L No. 119

In a hillside in the north-central part of sec. 15, T. 35 N., R. 9 E., about 7 feet of thin-bedded, compact, buff dolomite is exposed in an old abandoned quarry. The rock is of Early Silurian age. More than 50 acres with less than 6 feet of overburden is available. The nearest railroad, the Elgin, Joliet, and Eastern, is 3½ miles east of the exposure. Outcrops similar in character may be found along Dupage River and creeks in this vicinity.

Other outcrops which may furnish local supplies of road material are listed in Table 13.

TABLE 13.—*List of local outcrops of limestone in Will County*

Ref. No.	Part of section	Sec.	Township North	Range East	Description of formation
....	SE. ¼SE. ¼....	11	37	9	10 feet of thin-bedded dolomite
....	SW. ¼ SW. ¼...	26	37	9	4 feet of thin-bedded dolomite
....	SE. ¼ SW. ¼...	10	35	9	6 feet of thin-bedded dolomite in bank of DuPage River
....	SW. cor.........	16	35	9	4 feet of thin-bedded dolomite
....	NW. cor........	21	35	9	4 feet of thin-bedded dolomite
....	NE. ¼ SW. ¼...	33	35	9	8 feet of coarse-grained, coarsely crystalline limestone
....	NW. ¼ SW. ¼..	15	35	11	3 feet of thin-bedded dolomite along Hickory creek
....	SE. ¼ NW. ¼...	21	34	9	5 feet of thin-bedded, coarse, crystalline, dark-gray limestone
L No. 124...	SE. ¼ SW. ¼...	10	33	11	30 feet of coarse- and fine-grained, crystalline dolomite along Forked Creek
....	NW. ¼ SW. ¼...	15	32	10	10 feet of shaly and crystalline, thin-bedded, dolomite Forked Creek.

WINNEBAGO COUNTY

The bed rock of Winnebago County (fig. 38) consists of limestone and dolomite, but it is buried in most places by drift of such thickness as to make it unavailable for use as road material. There are however, several localities where small areas of rock may be obtained with only a thin covering of drift. Many of these localities are within reach of railroads and might serve as sites for shipping quarries should there be sufficient demand for their product. Localities which are distant from railroads may be used as a source of local supply.

There are two quarries with shipping facilities in the county and both of these are in the vicinity of Rockford. Rock for local use is being or has been quarried at several places.

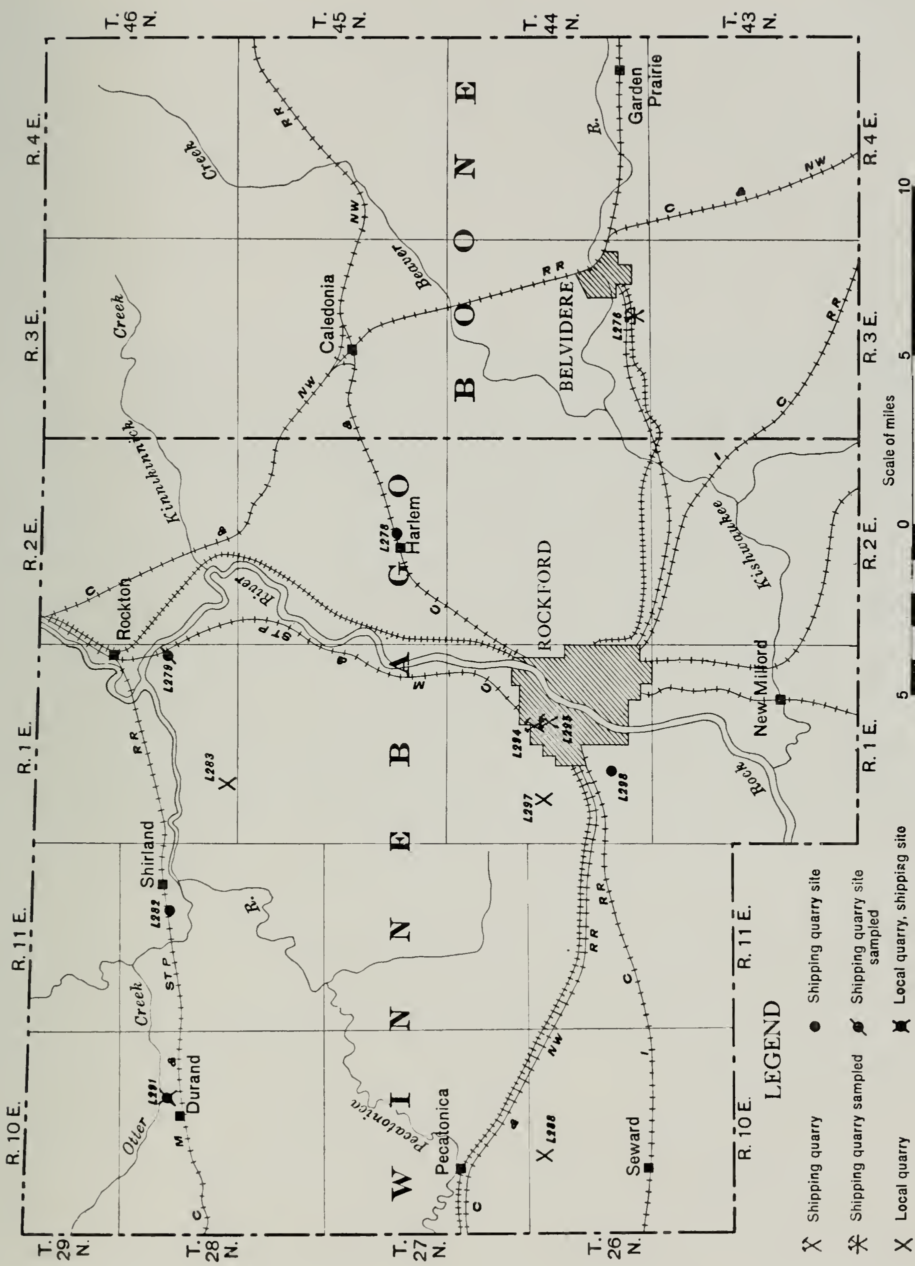

FIG. 38. Map of Boone and Winnebago counties showing location of quarries and quarry sites.

SHIPPING QUARRIES

L No. 294

Northern Illinois Supply Company
(Formerly the Carrico Stone Company)

The Carrico quarry is located in a hillside in the SE. ¼ NW. ¼ SE. ¼ sec. 15, T. 44 N., R. 1 E. The quarry is roughly circular in outline, has a diameter of about 500 feet and a 50-foot face.

The rock quarried is of Galena age and its character is shown in the following section and in figure 39:

	Thickness *Feet*
3. Dolomite, coarse-grained, crystalline, gray-buff; in beds 8 to 10 inches thick	25
2. Dolomite, medium-grained, crystalline, blue-gray; fossil fragments common	1-5
1. Limestone, fine-grained, brittle, gray, in beds 8 to 10 inches thick. Chert seams common. Possibly upper Platteville	22

The overburden is of clay till and sand ranging in thickness from 5 to 12 feet. The sand is sold for building purposes.

The rock is quarried in 9-foot benches. A 3¼-inch tripod drill and jack-hammers are used for drilling the blast holes. Blasting is done with 40 per cent dynamite.

The broken rock is loaded into 2 yard steel quarry cars by steam shovel, is pulled to the incline by horses and up the incline to the primary crusher by cable. Two crushers, a No. 6 and a No. 3 Austin gyratory, are used in crushing the rock and a 70-inch rotary screen is used to separate it into required sizes. Storage is provided by a 400-ton bin.

The capacity of the plant is about 350 tons. The daily production is about 200 tons, and the yearly production about 60,000 tons.

The crushed rock is used as road material, aggregate, and agricultural limestone. Most of the product is used locally.

The Chicago, Milwaukee and St. Paul Railroad provides transportation facilities.

L No. 295

Northern Illinois Supply Company
(Formerly the Hart and Page Stone Company)

The Hart and Page quarry is located in a hillside in the W. ½ SW. ¼ SE. ¼ sec. 15, T. 44 N., R. 1 E. It is worked as a pit, has a circumference of about 1,800 feet, and is about 100 feet deep. The overburden is black loam and averages about 2 feet in thickness.

The rock is Galena-Platteville and shows the following section:

	Thickness *Feet*
3. Dolomite, fine- and coarse-grained, gray to buff, in beds 14 to 16 inches	62
2. Dolomitic limestone, coarsely crystalline, blue-gray in beds 8 to 10 inches	6
1. Dolomitic limestone, finely crystalline, buff-gray in beds 3 to 6 inches	9
Water level.	

When the quarry was visited, operations were confined to working downward such parts of the quarry as had not been brought to the lowest level of the pit. The rock is quarried in 9-foot benches and the broken

Fig. 39. Cherty Galena dolomite in the quarry of the Carrico Stone Company, Rockford.

rock loaded by steam shovel into 3-yard cars which are drawn up an incline and dumped into a No. 6 Gates crusher.

A rotary screen separates the crushed rock into desired sizes. The sizes commonly prepared are ¼-inch, 1½-inch, and oversize (larger than 1½-inch), produced in the following respective proportions—10, 20 and 70 per cent. Storage is provided by a bin with a capacity of 300 yards and by yard space.

The product is used as road material, aggregate, and agricultural limestone. Some of the larger fragments are burned for lime. From 150 to 200 yards of crushed rock is produced daily.

Shipping facilities are furnished by the Chicago, Milwaukee, and St. Paul Railroad and by truck.

POSSIBLE SITES FOR SHIPPING QUARRIES

L No. 278

Forty-five feet of rock is exposed along the railroad cut in the SW. ¼ NE. ¼ SW. ¼ sec. 27, T. 45 N., R. 2 E., where the Chicago and Northwestern Railroad crosses a small creek and cuts through the adjoining hills. The north side of the cut reveals stone for a distance of about 1200 feet, and the south side for almost 3,000 feet. Because of the hilly character of the country the thickness of stone exposed varies, but it averages about 30 feet.

The overburden consists mainly of gravelly till and ranges in thickness from almost nothing to 25 feet. At the end of the cut toward the creek the overburden increases away from the creek so gradually that an area at least 150 feet wide is available with less than 10 feet of overburden and if the rock rises in the hills, as is probable, the width of this tract may be increased from 50 to 100 feet more. The rock exposed is Galena dolomite. It is coarsely crystalline and buff-gray in color, very similar to that at the Hart and Page quarry in Rockford. Though only 45 feet of rock is exposed, the rock probably continues in depth for at least 200 feet more. The stone at this outcrop was formerly quarried for building purposes.

If a satisfactory market can be obtained, stone can be procured here in large quantities.

L No. 279

In the SE. ¼ SW. ¼ SE. ¼ sec. 24, T. 46 N., R. 1 E., at the end of the ridge which extends northeast from the higher land to the west there is an area about 1,600 feet long and 300 feet wide underlain by at least 45 feet of stone exposed in an abandoned quarry. It is probably that the overburden on the entire ridge averages less than 10 feet, so that at least 40 acres would be available for quarrying under these conditions.

The rock is probably of Platteville age and is a finely crystalline, gray-white limestone in beds averaging 12 inches in thickness. Commonly the upper 10 feet is badly weathered and broken but the lower beds appear hard and fresh. There is some variation in texture of rock both vertically and horizontally. In places a buff porous layer is found. This bed, however, does not reach a great thickness, and is probably not worthy of special consideration if the quarry is being worked for crushed stone.

Some rock has been quarried for lime and at present the Bradley and Smith Construction Company of Chicago are quarrying rubble and dimension stone here for a construction of a power dam above Rockton.

Transportation facilities might be obtained from the Rockford and Interurban Electric which runs within 900 feet of the hill, or from the Chicago, Milwaukee and St. Paul Railway about one-quarter of a mile to the east.

L No. 282

About 40 feet of stone outcrops in a hillside along the Chicago, Milwaukee and St. Paul Railway in the east-central part of sec. 10, T. 28 N., R. 11 E. The outcrop is about 400 feet long, but the rock doubtless underlies the entire hill. Though the rock does not outcrop in the upper 40 feet of the hill, it probably will be found within 10 or 15 feet of the surface and if such is the case there would be about 10 acres available with less than 10 feet of overburden.

The rock is of Platteville age, and consists of fine-grained, limestone beds, 1 to 3 inches thick, separated by thin partings of shale. The limestone appears to become more massive and thicker-bedded with increasing depth. Stone for local use has been quarried from this hill.

L No. 291

A small quarry located in sec. 10, T. 28 N., R. 10 E., near Durand, and described in the notes on local quarries, might be developed into a shipping quarry could a suitable market be found.

L No. 297

This site located in sec. 17, T. 44 N., R. 1 E. and described under local quarries, might possibly be considered as a desirable location for a shipping quarry.

L No. 298

In the SE. ¼ NW. ¼ SW. ¼ sec. 28, T. 44 N., R. 1 E., about half a mile southwest of Rockford there is a hillside exposure of rock about 1,400 feet long and 40 feet high.

The rock is of Galena age and is a coarsely crystalline, gray-buff dolomite, in beds averaging about 10 inches in thickness. The overburden is of clay till which increases in thickness toward the top of the hill, but at least 10 acres is available with less than 10 feet of overburden.

Stone for local use has been quarried here and in an adjoining quarry of similar character by Rockford Township.

LOCAL QUARRIES

L No. 283

A small quarry has been operated in the NW. ¼ NW. ¼ SE. ¼ sec. 32, T. 46 N., R. 1 E. in an 18-foot exposure of rock 125 feet long situated at the nose of the hill.

The lower slope of the hill is practically free from overburden but toward the top the overburden is thicker and conceals the rock. It is probable, however, that limestone rises in the hill and that the maximum thickness of overburden is not greatly in excess of 15 feet.

Large amounts of rock are available, but the lack of transportation facilities makes this site mainly of local importance.

The rock is Platteville limestone, fine-grained, buff, and in beds 1 to 8 inches thick. The heavier beds are commonly near the base of the outcrop.

A No. 3 Austin crusher was used in crushing the rock.

L No. 288

About 44 feet of rock is exposed in a small quarry located in the nose of a hill in the SW. ¼ NW. ¼ SW. ¼ sec. 4, T. 26 N., R. 10 E.

The rock is coarsely crystalline Galena dolomite and is badly weathered in the upper part.

The overburden of clay till increases in thickness toward the top of the hill where it is about 25 feet thick. However, about 3 acres are available along the slope on which the overburden averages less than 10 feet.

The rock is crushed in a No. 3 Austin jaw crusher and screened over ½-inch screen. The oversize and screenings are used as road materials. The quarry is operated when the demand warrants.

L No. 291

A small quarry is located in the cen. W. ½ NE. ¼ of sec. 10, T. 28 N., R. 10 E. about half a mile north of Durand. It is situated in the hillside and a face about 35 feet high and 200 feet long is being worked. The overburden is mainly clay till which increases in thickness back from the outcrop. Though no rock is exposed in the upper 25 feet of the hill, it is probable that it rises with the surface of the hill to some extent.

The rock is of Platteville age, and has the following section:

	Thickness *Feet*
3. Limestone, compact, finely crystalline, gray-buff; in beds 1 to 3 inches	13
2. Limestone, moderately finely crystalline, gray-buff; in beds 8 to 20 inches	21
1. Limestone, coarsely crystalline, hard, blue	1
Total	35

About 2 acres is available with less than 10 feet of overburden. Should it be found that the rock rises in the hill, large quantities of stone would be readily available and as the deposit is within half a mile of the Chicago, Milwaukee and St. Paul Railroad, it might serve as a shipping quarry.

The rock is worked in two benches, an upper one of 13 feet and a lower one of 21 feet. A well drill is used for putting down the holes and 40 per cent dynamite is used in blasting. The broken rock is hand loaded into one-yard carts which are pulled to the crusher by horses. The carts are then unloaded by hand into a No. 3 Austin crusher. Two sizes of crushed rock are produced, ½-inch and 1¼-inch. About 50 yards of crushed stone can be produced daily.

L No. 297

Rock for local roads is quarried in the SW. ¼ SE. ¼ SW. ¼ sec. 17, T. 44 N., R. 1 E., by Rockford Township. The quarry is located in a hillside and exposes a face 21 feet high and 400 feet long. The overburden of clay till increases in thickness toward the top of the hill and may be as much as 20 feet thick. It is probable, however, that the rock rises beneath the drift so that the thickness of overburden may consequently be somewhat less. About 8 acres is available with less than 10 feet of overburden.

An Indiana Road Machine Company crusher with a 12- by 18-inch jaw is used for crushing the rock, which is sorted in three sizes—½-inch stone, 1½-inch stone, and oversize.

The quarry is worked only intermittently. The rock is of Galena age and is coarsely crystalline dolomite in 1- to 12-inch beds.

An old abandoned quarry, once the source of ballast for the Rockford and Interurban Electric Railroad, is located about 200 feet east of L No. 297.

LOCAL QUARRY SITES

The following deposits which may serve as sources of crushed rock for local use do not constitute all the outcrops of this character which occur, but they are typical and represent in a general way all of the other outcrops. Many others may be found in the vicinity of those listed.

Sec. 25, T. 26 N., R. 11 E.

This outcrop, located in the valley of a small creek in the Cen. W. ½ sec. 25, T. 26 N., R. 11 E., consists of 23 feet of coarsely crystalline, Galena dolomite in beds 1 to 3 inches thick. The overburden is clay till and thickens rapidly away from the stream. Only a narrow strip along the lower slope is available with less than 10 feet of overburden.

Sec. 7, T. 43 N., R. 2 E.

Sixteen feet of coarsely crystalline Galena dolomite outcrops along the lower slopes of the hill in the W. ½ NE. ¼ SW. ¼ sec. 7, T. 43 N., R. 2 E. Only a narrow strip is available with less than 10 feet of overburden.

Sec. 7, T. 43 N., R. 2 E.

About 23 feet of thin-bedded, coarsely crystalline Galena dolomite outcrop in the bluffs of a small creek in the S. ½ SE. ¼ SW. ¼ sec. 7, T. 43 N., R. 2 E. At least 65,000 yards is available here with less than 5 feet of overburden.

Sec. 18, T. 43 N., R. 2 E.

Forty-eight feet of coarsely crystalline Galena dolomite outcrops in the bluffs of a small creek in the NW. ¼ SW. ¼ sec. 18 T. 43 N., R. 2 E. The exposure is about 1,500 feet long and a strip about 100 feet wide is available with less than 10 feet of overburden.

Outcrops of Galena dolomite similar in character to those already mentioned occur in the following localities:

TABLE 14.—*Other outcrops of Galena dolomite in Winnebago County*

Section	Part of section	Township North	Range East
20	N. Central	27	10
33	SW. ¼ SW. ¼ SW. ¼	27	11
11	W. ½ SE. ¼	26	11
18	NE. ¼ NW. ¼	26	11
34	SW. ¼ NE. ¼	44	1
29	SW. ¼ SW. ¼ NE. ¼	44	2
20	NW. ¼	43	1

Outcrops of Platteville limestone similar in character to outcrops previously occur as follows:

TABLE 15.—*Other outcrops of Platteville limestone in Winnebago County*

Section	Part of section	Township North	Range East
35	Cen. SW. ¼	29	11
11	SW. ¼ NW. ¼	28	10
25	NW. ¼ NW. ¼ NE. ¼	28	10
2	NW. ¼ SE. ¼	28	11
15	Cen. E. ½ NE. ¼	28	11
10	Cen. S. ½ NE. ¼	27	10

CHAPTER VIII.—LIMESTONE RESOURCES OF ILLINOIS—THE WESTERN DISTRICT

By Frank Krey and J. E. Lamar

The western district (fig. 1) comprises a narrow strip along Mississippi and Lower Illinois rivers extending from Rock Island to Randolph counties inclusive. Limestone outcrops are abundant throughout the region along the river bluffs, but the largest production of limestone comes from the vicinity of Alton and East St. Louis. The counties included in this district are:

Adams	Mercer
Calhoun	Monroe
Greene	Pike
Hancock	Randolph
Henderson	Rock Island
Jersey	Scott
Madison	St. Clair

ADAMS COUNTY

The Keokuk-Burlington limestone comprises the bed rock in most of the western part of the county (fig. 40), but is everywhere so deeply covered by drift and loess as to be available only along the Mississippi River bluff and along the creeks in the vicinity of the bluff.

There are at present four quarries operating in the river bluff, three in sec. 23, T. 2 S., R. 9 W., about a mile south of Quincy, and the fourth on Mill Creek at Marblehead. All of the quarries are located on or near the Chicago, Burlington, and Quincy Railroad and have connection with the Wabash Railroad at Quincy. The quarries in sec. 23 are operated by the F. W. Menke Stone and Lime Company, the Quincy White Lime Company, and the Black White Limestone Company. The quarry at Marblehead is operated by the Marblehead Lime Company.

SHIPPING QUARRIES

K No. 110

SE. 1/4 sec. 23, T. 2 S., R. 9 W.

The F. W. Menke Stone and Lime Company

The quarry face is about a quarter of a mile long and shows a thickness of 50 to 60 feet of rock. The rock is a coarsely granular, gray limestone, containing considerable quantities of chert as nodules and layers. In gen-

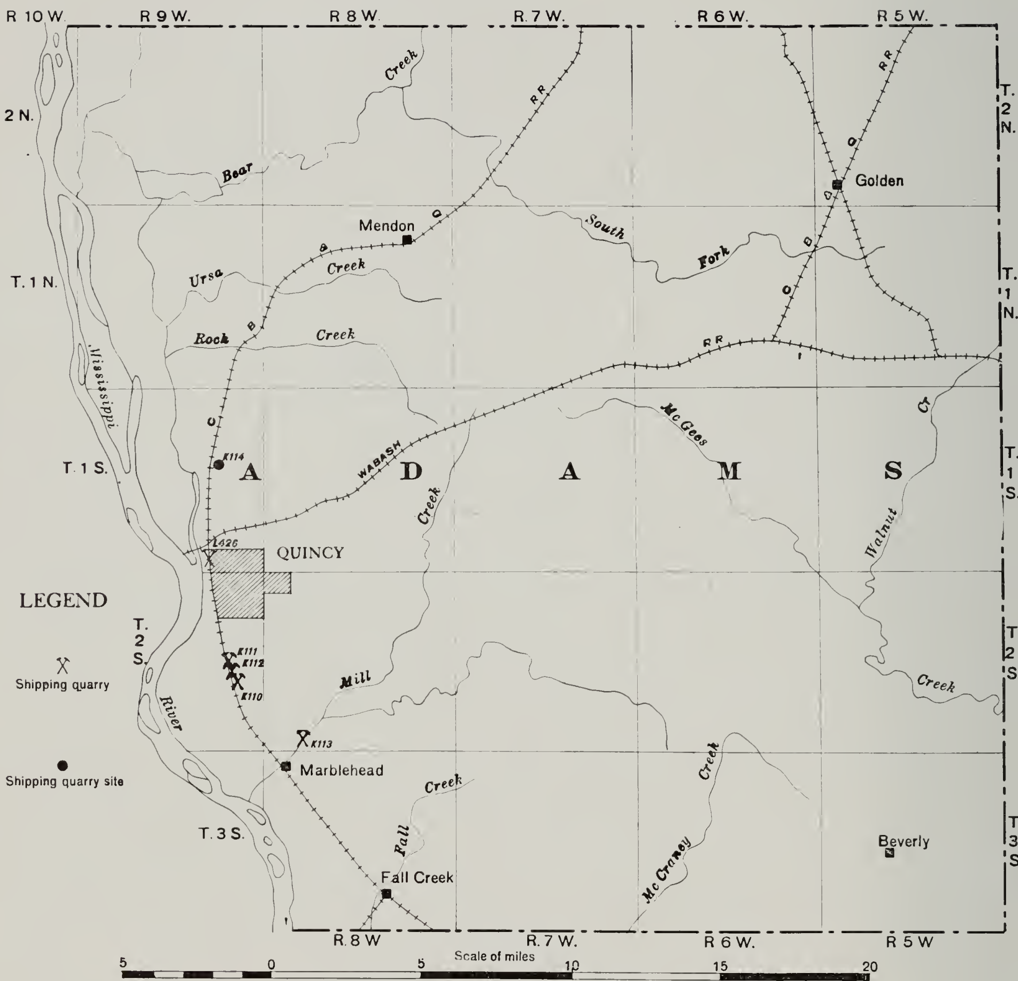

FIG. 40. Map of Adams County showing location of quarries and quarry sites.

eral, the upper part of the formation is thinner-bedded and more cherty, in some places containing nearly 50 per cent chert. The lower 20 to 30 feet is usually more massive and is locally entirely free from chert. It is this lower portion which is being quarried in the vicinity of Quincy for burning into lime. The upper cherty and thinner-bedded rock is used for riprap, dimension stone, or is crushed for aggregate. About 50 tons of crushed stone are produced daily.

The overburden consists of loess which averages about 15 feet near the quarry but increases back from the face and reaches thicknesses of 50 to 60 feet.

In quarry practice, the upper 25 to 30 feet of thin-bedded and cherty stone are first "shot down", and then the lower 30 feet quarried. The broken rock is loaded into wagons and hauled to crushers or kilns. The crushing machinery includes two Austin crushers, a No. 2 and a No. 3, and a 24-inch screen is used in sorting crushed rock into required sizes.

The rock is too soft for use as road material where that material is subject to much wear, but may be used to advantage as aggregate and as base material in roads.

K No. 111

Black White Lime Company

NE. ¼ sec. 23, T. 2 S., R. 9 W.

The face of the quarry of the Black White Lime Company is about 1100 feet long and 70 feet high. The rock quarried here is similar in character to that of the other quarries in the vicinity. The overburden consists of loess and averages about 15 feet in thickness.

In quarrying, the rock is blasted down in benches of about 15 feet. It is also being mined. Air drills working on a column are used for drilling the blast holes. The broken rock is loaded into one yard wagons and hauled to crushers or kilns. The crushing machinery consists of two Universal jaw crushers, a No. 5 and a No. 2, a Type 7 Maxecon Mill for pulverizing and a 4- by 12-foot cylindrical screen.

The stone is quarried primarily for making lime, but such portions as are unsuited to this purpose because of size or composition are made into crushed stone for aggregate and agricultural limestone. Limestone dust 80 per cent of which will pass a 200-mesh screen is also produced. The daily production of the plant is about 50 tons and its capacity about 100 tons. The yearly production is 2,500 tons pulverized limestone, 10,000 tons crushed stone and 20,000 tons for lime.

The rock is in general too soft for use as a road material except where it will not be subjected to extensive wear.

K No. 112

Quincy White Lime Company

SE. 1/4 NE. 1/4, sec. 23, T. 2 S., R. 9 W.

The quarry of the Quincy White Lime Company has a face of rock 1,000 feet long and 75 feet high. The overburden consists of loess which has an average thickness of 25 feet.

Formerly the whole face was quarried, but because of the increased thickness of overburden away from the face and the large amount of chert in the higher limestone beds, mining by the room and pillar method was resorted to. The rooms are 45 feet wide, 20 feet high, and have 25-foot pillars left for support. Only the lower 20 feet of rock is mined. The full face is broken at one time. The drill holes, 7 feet deep and 2½ inches in diameter, are placed from 6 to 8 feet apart horizontally and 4 feet vertically, and are shot with 40 per cent dynamite. The broken rock is sledged or block-holed to man size and loaded by hand into carts which are hauled to the crusher.

The crushers are two in number, a No. 5 and a No. 3 Gates. Any size, from dust to 2 inches can be produced. The character of the rock is similar to that of the other quarries in this vicinity, and is used for the same purposes. About 100 tons of crushed rock are produced daily.

K No. 113

Marblehead Lime Company

SW. 1/4 sec. 32, T. 2 S., R. 8 W.

This quarry is located in the creek bluff, is about 1,800 feet long, and has a face 55 feet high. The overburden is of loess and averages about 20 feet in thickness. Here, as at the quarry of the Quincy White Lime Company, only the lower 20 to 25 feet of rock is used, and the same mining methods employed there are also in use here. However, in handling the broken rock it is loaded into small 2-ton cars which are pushed to the entrance of the workings and hauled by a small locomotive to the plant.

The crushing machinery consists of a No. 3 Gates crusher and a No 18 American Pulverizer.

The rock obtained is from the same horizon as that worked at the other quarries and is almost identical in character. Most of it is used in the production of lime but some of it is ground for agricultural limestone of which about 20 tons are produced daily.

L No. 426

Quincy City Quarry

The Quincy City quarry is located in a hillside in the City of Quincy and has a straight face forty feet high. The overburden is clay and is fourteen feet thick. It is removed by teams and scrapers.

The rock is quarried in three or four benches varying from eight to ten feet in height. The holes for blasting are drilled with tripod drills and the rock shot down with dynamite. It is loaded by hand into two-ton quarry cars, pulled by horse to the incline and thence by cable to the crusher. The crushing machinery consists of an Austin gyratory No. 5 and a Champion jaw crusher. Two Austin screens, 36 inches by 18 feet are used to size the stone.

The stone is used for roads, concrete aggregate, agricultural limestone and for bridges. The average daily production is about 300 tons.

The quarry is located on the Chicago, Burlington and Quincy Railroad, and ships stone over this road, the Wabash and the Quincy, Omaha, and Kansas City railroads.

POSSIBLE SHIPPING QUARRY SITES

K No. 114

Only along the river bluff from the south line of the county to Rock Creek is limestone found close to the railroad. Along this entire distance, the bluff is practically continuous except where broken by creeks or ravines. The rock is exposed to heights of from 25 to 70 feet above the flat, but the lower portions of the slopes are generally talus covered though the amount of talus varies from place to place. This loess is present everywhere along the bluff and reaches a thickness of from 30 to 50 feet within 100 to 200 feet back from the edge of the bluff.

The exposed rock is a coarsely granular limestone. The lower 20 to 30 feet is massive and practically free from chert, but the upper portion of the rock is thinner-bedded and contains large amounts of chert as thin irregular layers and nodules. The distribution of the chert is irregular, and while layers several feet thick may locally be entirely free from chert the same layers may elsewhere consist of 50 per cent chert.

Near the south line of the county the lower slopes of the bluff are composed of the green, sandy shales of the Kinderhook formation. Due to the northeast dip of the rocks, the lower massive limestone comprises the bluff from a little south of Marblehead to the town of Quincy, but northward from Quincy the higher, more cherty limestones make up the bluff. Consequently the thickness of rock available for quarrying increases northward. South of Quincy, the available rock is limited to the rock above the flat, but north of Quincy there is available besides the thickness exposed in the bluff an increasing depth below the level of the flat. The height of the bluff varies from less than 25 feet to as much as 75 feet.

As shown by tests, the rock is somewhat soft for use as road material except where not subjected to much wear. It is satisfactory, however, for use as aggregate in concrete and the high degree of purity of the limestone makes it suitable for use as agricultural limestone and lime. Because of the ease with which it can be ground to a powder it may also be used as whiting.

As a possible quarry site the bluff lacks several advantages. The rock is not especially well suited to use as road material, and for other purposes the best sites are preempted by quarries already in operation. The large quantity of chert destroys the uniformity of the rock, and hand picking would be necessary to prepare the rock for purposes requiring a pure limestone. Although the immediate edge of the bluff may be free from loess yet within 200 feet from the edge the overburden reaches 30 feet or more, and if wide areas are considered, the overburden will average between 30 and 50 feet.

Rock for local use may be obtained nearly anywhere along the bluff and along the valleys of the streams that intersect the bluff.

CALHOUN COUNTY

Calhoun County (fig. 41) is entirely without railroad facilities but the high limestone bluffs bordering Mississippi River in the southern part of the county may prove an important source of crushed limestone should water transportation prove feasible.

POSSIBLE QUARRY SITES

The Mississippi River bluff from the southern end of the county to within a mile of West Point Landing is composed of St. Louis limestone, and where not eroded by ravines or creeks this limestone forms conspicuous bluffs. Throughout this whole region the bluffs are close to the water's edge.

The thickness of rock is variable. In the southern end of the county very few portions of the bluffs are more than 30 feet high, but northward to the end of its outcrop the bluff may increase to a height of 100 feet. However, a narrow strip along the edge of the bluff is practically free from overburden in most places, but within 100 feet of the edge the overburden is usually 30 feet or more.

At the time of investigation no rock was being quarried along the river, but in times past the stone in the bluff has been quarried in many places to provide riprap for river work. Such rock was obtained at West Point Landing, just south of Martins Landing and also in the vicinity of Brooks Landing.

The rock is light-gray in color and somewhat variable in texture. Some layers are granular or crystalline, others shaly, and still others so dense as to simulate lithographic stone. In most respects the rock resembles that at Alton, and can be expected to give similar results in tests.

As a possible quarry site the region presents some disadvantages, the chief of which are lack of railroad transportation and the comparatively great thickness of overburden. On the other hand the excellent character of the rock and the large amount available, as well as the possibility of removing the overburden by hydraulic methods are favorable to this region. Should water transportation prove feasible, this region could furnish large quantities of limestone suitable for many uses, such as road materials, lime, agricultural limestone, flux, whiting, and aggregate.

OUTCROPS MAINLY OF LOCAL IMPORTANCE

Rock for local use may be obtained practically any where along the bluff on both east and west sides of the county, and all the streams show rock along their lower courses. An east-west fault which crosses the county near Dogtown Landing about a mile below West Point, causes rocks of St. Louis age to be exposed on the bluffs to the south, while north of the bluff rocks as old as Ordovician appear at the surface. The rocks to the north of the fault, however, dip to the northeast so that successively younger formations succeed one another northward from the fault.

The Ordovician limestones which appear in the bluff north of the fault are the Joachim, the Plattin, and the Kimmswick. The Joachim is a brown or buff, somewhat earthy, magnesian limestone. The Plattin is dark-gray or drab-colored, fine-textured limestone, and the Kimmswick is a coarsely crystalline limestone similar to the rock exposed at Valmeyer and Thebes in Alexander and Monroe counties. The Joachim and Plattin limestones have been quarried in the river bluff at West Point. These limestones do not appear in the Illinois River bluff, and on the Mississippi River side disappear below the surface about three miles north of Batchtown. Farther north the next limestones to appear in the bluff are the Silurian and Devonian, which are separated from the Ordovician limestone by a shale interval of about 75 feet. The Silurian and Devonian limestones outcrop on both sides of the county. On the Mississippi side they are found in the bluff as far as the north line of the county and on the Illinois side they dip below the surface a short distance north of Hardin.

The limestones vary widely in character. The Devonian limestone is a light-gray, granular rock in beds few of which are over 4 feet thick, and the Silurian limestones may be buff-colored, fine-grained to granular. Of the Silurian limestones the beds most suitable for road material are the massive light-colored ones which outcrop in the northern portion of the county.

Above the Devonian limestone and separated from it by 40 to 100 feet of shale, is the Burlington limestone. This limestone forms important bluffs along Illinois River and comprises the river bed over most of the county.

The character of the rock is here similar to what it is at Quincy, Adams County and in Pike and Jersey counties. It is probably too soft for road material, but where free from flint it is a pure limestone and lends itself readily to any uses to which a pure limestone can be put.

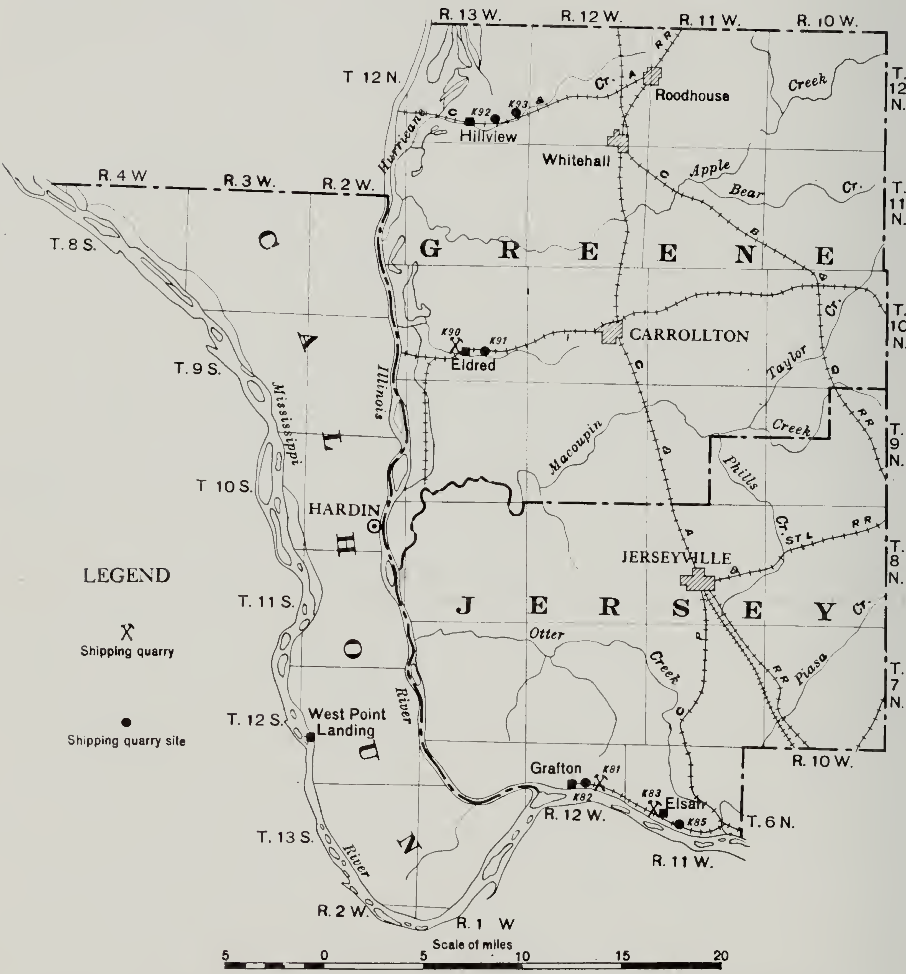

FIG. 41. Map of Greene, Calhoun and Jersey counties showing location of quarries and quarry sites.

GREENE COUNTY

The entire western half of Greene County (fig. 41) is underlain by limestones of Lower Mississippian age, but because of the great thickness of drift, 30 feet and more, the limestone is available only in narrow strips along stream valleys. The most promising outcrops are found along the Illinois River bluffs.

SHIPPING QUARRIES

There is only one shipping quarry within the county—that of the Eldred Stone Company, which is located along the Chicago and Alton Railroad near Eldred.

K No. 90

Eldred Stone Company

Sec. 28, T. 10 N., R. 13 W.

The Eldred Stone Company operates a quarry on the north side of the railroad, where the bluff of a small creek intersects the Illinois River bluff.

The quarry is bow-shaped in outline and about 250 feet long. The overburden consists of loess and though the average thickness at the quarry is only about 8 feet, it increases rapidly in thickness away from the face and in less than 100 feet reaches a thickness of 30 feet and more.

A face of rock about 7 feet high is being worked. The rock is a part of the Burlington formation and is a massive, coarsely granular limestone. It occurs in beds 4 inches to 2 feet thick. Considerable chert is present in layers and nodules which do not appear to be restricted to any definite horizon, but retain a rudely horizontal arrangement. Probably less than 5 per cent of the face consists of chert.

In quarrying, the overburden is removed by hydraulic methods and washed into a nearby creek. Blast holes are drilled with 2-inch steam drills to a depth of approximately 16 feet, and 40 per cent and 60 per cent dynamite are used in blasting. The broken rock is loaded by hand into 1½-yard cars which are pushed to the crusher and dumped.

Two Austin Crushers, a No. 5 and a No. 3 are used to crush the rock and two pulverizers are used for preparing a finely ground product.

The crushed rock is prepared only on demand, most of the stone being used for agricultural limestone or as fine limestone powder. The daily production is 80 to 90 tons of ground limestone, or 200 tons of crushed rock.

POSSIBLE QUARRY SITES

The Illinois River bluff, except where intersected by creeks, presents a face of solid rock between 50 and 100 feet high, but railroad transportation is available at only two places along the bluff in the vicinity of Hillview in the northwest part of the county, and at Eldred in the southwest part of the county.

K Nos. 92, 93

Hillview region

The Chicago and Alton Railroad, which follows the valley of Hurricane Creek, intersects the bluff at Hillview. In the immediate vicinity of Hillview the Illinois River bluffs are low and at some distance from the railroad, but eastward from Hillview along Hurricane Creek, and where these bluffs come close to the railroad as in secs. 25 and 26, T. 12 N., R. 13 W. they may serve as sources for crushed stone.

The height of the bluffs ranges from 60 to 100 feet. The lower portion, except where it forms the creek bank, is generally covered by talus, but above the talus there is a vertical face of rock 20 to 40 feet high. As at other bluff localities, the rock is capped by loess of varying thickness. At the edge of the bluff the loess is practically negligible, but it rises rapidly back from the bluff and at 100 to 200 feet back it reaches a thickness of 30 feet or more.

The rock is similar to that quarried at Eldred, and is only indifferently suited to use as road material.

K No. 91

Eldred area

The quarry of the Eldred Stone Company is already located in this area, but other quarries might be opened here should conditions be warranted.

The branch of the Chicago and Alton Railroad which runs from Eldred to Carrollton follows the valley of a small creek for several miles east from Eldred. This creek is also flanked by bluffs for some distance upstream from the Illinois River bluffs, and on the north side where the bluff is close to the railroad, rock can be obtained under conditions similar to those of the quarry of the Eldred Stone Company. In the Illinois River bluffs north of Eldred, the rock stands with vertical face 10 to 80 feet high. It is also capped by loess, the thickness of which may reach 60 feet or more. Generally, however, the area immediately adjoining the bluff shows little or no overburden, but back from the face the overburden increases rapidly in thickness and within 150 feet of the bluff it is more than 30 feet thick.

Rock could be obtained here in large quantities if it is found feasible to remove 40 feet of overburden. The rock is identical with that at Eldred, and can be used for the same purposes.

ROCK FOR LOCAL USE

The Illinois River bluff and all the bluffs and banks of the intersecting creeks for several miles back from the Illinois River bluff show limestone, which is available for local use. Most of this limestone is covered by a considerable thickness of loess or drift except at the immediate stream banks. However, by working along the outcrop sufficient stone for local use is available at most exposures.

Towards the center of the county the limestone outcrops become less numerous, and in the western portion of the county no limestone outcrops were observed.

In the central portion of the county outcrops of limestone were observed along the creek in the NW. ¼ sec. 12, and in the NE. ¼ sec. 25, T. 11 N., R. 12 W., along the creek near the center of sec. 10, T. 11 N., R. 11 W., on a small branch in the SW. ¼ sec. 36, T. 10 N., R. 12 W., and along the creek in the NW. ¼ sec. 16, T. 9 N., R. 11 W.

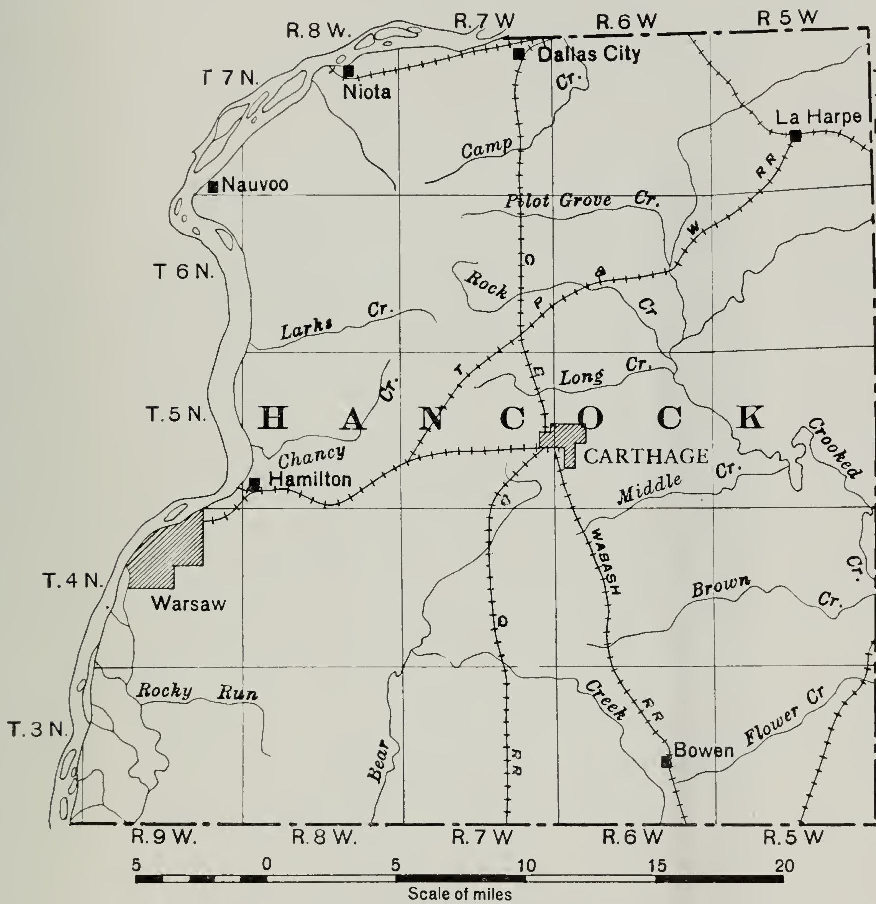

Fig. 42. Index map of Hancock County.

At all these localities the rock outcrops are limited to the bed or bank of the stream. Only a few are more than 10 feet high and are covered by drift which increases in thickness from almost nothing at the outcrop to 10 feet or more within 50 feet of the exposure. The amount available at any one locality is probably limited. However, sufficient stone for use as aggregate in concrete for bridges and culverts might readily be obtained.

HANCOCK COUNTY

Most of Hancock County (fig. 42) is so thickly covered with drift that rock outcrops are limited to the river bluffs and valleys of the larger streams which intersect the bluff.

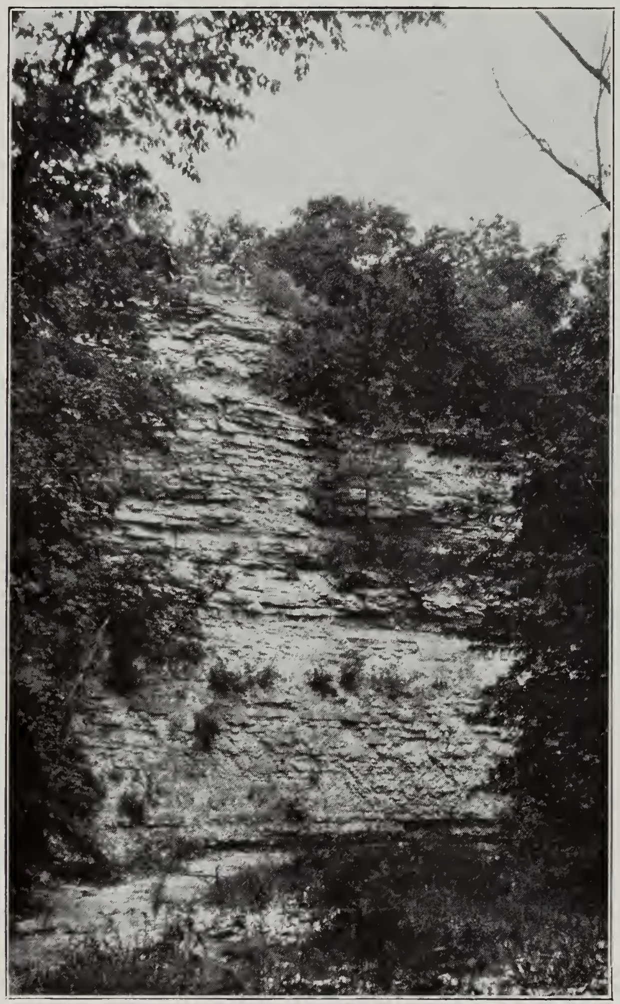

Fig. 43. Keokuk limestone at Cedar Glen near Hamilton.

The rocks comprising the bluffs are the St. Louis limestone, the Warsaw-Spergen formation, and the Keokuk limestone. Of these formations only the Keokuk offers possibilities as a source of road material. Since this formation is prominent in the bluffs only along the lower slopes, few good exposures are found except at the intersections of creeks with the bluff and then mainly in the narrow ridges from which the overlying Warsaw-Spergen has been removed by erosion.

The Keokuk limestone (fig. 43) is a moderately coarse-grained limestone which in favorable localities is exposed in a face 50 feet or more in height. It is comparatively free from chert except near the base of the formation, but at most localities it contains beds of soft, earthy, dolomitic limestone interbedded with the harder layers. As a road material it is somewhat soft, similar to the rock at Quincy. Analyses from samples from Nauvoo and Warsaw are shown in Table 17.

Railroad transportation is available along the bluffs only between Warsaw and Hamilton and between Niota and Dallas City.

It is doubtful whether any of the localities along the railroads can be considered as possible sites for shipping quarries because of the heavy overburden and necessity for sorting out the softer layers. However, moderately large amounts of rock can be obtained at several places along the railroad between Warsaw and Hamilton and under favorable conditions might serve excellently to supply a temporary or local demand. Between Niota and Dallas City the railroad is as much as three-quarters of a mile from the bluffs in places. In the same area the rock outcrops only along the foot of the bluff and at no locality is any amount of rock available without more or less extensive development work.

Small amounts of rock for local use may be obtained almost anywhere in the vicinity of the bluff, or along the valleys of the larger creeks which intersect the bluff.

HENDERSON COUNTY

Henderson County affords few outcrops of limestone suitable for use as road material. Most of the county is deeply covered with drift and even the bluffs which farther south show good exposures of rock, consist here of low hills covered with silt and loess. Consequently rock exposures are few. The best exposures are found along the valleys of the larger streams and their tributaries.

SHIPPING QUARRY

K No. 125

There is one shipping quarry in the county, the Monmouth Stone Company,[1] which is located along South Henderson Creek, about one mile east of Gladstone.

The quarry is located along the lower slope of the creek bluff and has a face about 50 feet high and about 1,000 feet long.

[1] The Monmouth Stone Company filed a petition of bankruptcy in 1924 and the property was sold at auction to the bondholders of the company. It is reported that the bondholders intend to resume operations. (Rock Products, Vol. XXVII, No. 25, Dec. 13, 1924.)

The rock quarried is the Burlington limestone and is essentially a cherty, coarsely granular limestone. As exposed in the quarry face the upper 10 feet of rock is weathered and consists of chert layers interbedded with some shaly beds. Below this there is about 20 feet of cherty, granular limestone which is in turn underlain by about 18 feet of limestone containing minor amounts of chert.

The overburden consists of loess and fine sand and reaches a maximum thickness of over 30 feet, but because of the many small ravines and gulleys it is not of uniform thickness.

Stripping is done by means of a steam shovel, which loads the overburden into 6-yard cars which are then hauled by a locomotive to a nearby dump. That part of the overburden which is fine sand has been found suitable for use as molding sand and much of it is shipped for that purpose.

The crushing plant has been erected only recently, and little more than development work has been done. No definite methods of quarry practice have been determined. It is planned, however, to quarry the entire 50-foot face using well drills to put down blast holes, and 40 per cent dynamite for blasting. The holes are to be spaced 25 feet back from the face and about 14 feet apart. The broken rock will be handled by a 2½-yard steam shovel which will load into 6-yard side dump-cars and these will be drawn to the primary crusher by locomotives.

The company has a very modern crushing plant which contains a No. 12 Allis-Chalmers gyratory for a primary crusher, and a battery of four No. 5 gyratory crushers for the secondary crushing. The screening is done by three 54-inch rotary screens which separate out the coarse material and two sets of vibrating screens which sort the finer material. Each of the units is driven by a separate motor. The motors are operated by power obtained from Keokuk.

The crushed rock is to be sold for all common purposes, road material, agricultural limestone, railroad ballast, and aggregate.

Shipping facilities are provided by the Chicago, Burlington and Quincy Railroad.

OTHER SOURCES OF LIMESTONE

No other localities offering favorable conditions for the development of shipping quarries were noted. Examination of the Mississippi River bluff shows mainly a range of comparatively low-lying hills with occasional outcrops of limestone at their bases. Unfortunately the rock is so deeply covered with drift, sand, and loess that the cost of quarrying would be prohibitive of successful large-scale operations.

Back from the bluff the rock is deeply buried beneath glacial drift and outcrops are confined to the larger streams and their tributaries. No traverses of these streams were made but outcrops which might serve as a source of crushed rock for local use are reported from along South Henderson Creek and along Dugout and Ellison creeks, especially in the western portion of the county. Exposures of Burlington limestone are also reported from along Smith Creek in secs. 19, 20, and 21, T. 11 N., R. 4 W.

JERSEY COUNTY

DESCRIPTION OF ROCK FORMATIONS

Though limestone outcrops along the Illinois River bluff and along most of the stream valleys tributary to the Illinois, it is only along Mississippi River from Grafton to the mouth of Piasa Creek that the rock is near a railroad (fig. 41).

The rock in the bluff ranges in age from Silurian (Niagaran) to Mississippian (Salem) and owing to the eastward dip of the rocks the different formations succeed one another in making up the bluff. Thus the bluff extending about a mile east from Grafton consists of Niagaran dolomite, which is in turn overlain by the Devonian and Kinderhook formations. Since they are comparatively thin and non-resistant, the latter formations are not prominent in the bluff. East of the Kinderhook formations, the Burlington and Keokuk which are composed mainly of limestone, comprise the prominent bluff-forming rocks from about 2 miles east of Grafton to where the bluff ends near the mouth of Piasa Creek near the county line.

SHIPPING QUARRIES

K No. 81

Columbia Quarry Company

NW. ¼ NW. ¼ sec. 14, T. 6 N., R. 12 W.

Quarry No. 4 of the Columbia Quarry Company is located in the river bluff and is about 600 feet long and has been worked back almost 100 feet. The face is about 40 feet high. The overburden is brown loess. It is removed by hydraulic methods into Mississippi River. At the quarry edge the loess does not exceed 8 feet in thickness but as the bluff rises 50 feet higher it is probable that the overburden increases considerably and that the Devonian limestone and Kinderhook shales will be found overlying the dolomite. Inasmuch as the Devonian limestone reaches a thickness of more than 10 feet in but few localities in this region, while the Kinderhook shale may be over 100 feet thick, the presence of any considerable thickness of these formations will limit the extent to which quarrying can be carried back into the bluff.

In quarrying the rock is blasted down in 3 or 4 benches from 8 to 12 feet in height. The holes are made with steam tripod drills and 40 per cent dynamite is used in blasting. Pieces of broken rock too large to handle are further reduced to "man-size" by sledging, dobying, or block-holing. The stone is hand-loaded into 4-yard cars, pulled by mules to a derrick which dumps the cars. A No. 6 Austin crusher and a 6-foot flat bar screen complete the quarrying equipment.

The rock which is of Niagaran age is a uniform buff, finely crystalline, even-grained dolomite, in beds 4 inches to 3 feet thick. It was formerly much used for building stone, but with the advent of concrete its demand for building stone decreased. It is now quarried for use as riprap along Illinois and Mississippi rivers for aggregate, roadstone and ballast. The daily production is about 450 tons and the yearly production about 40,000 tons.

K No. 83

Quarry of Western Whiting Manufacturing Company

The quarry in the Mississippi River bluff at Elsah is about 300 feet long and shows a face 160 feet high. The overburden consists of loess and brown sand averaging about 6 feet in thickness at the quarry face, but back from the face the thickness of loess increases and probably averages 25 feet or more. It is removed by teams and scrapers.

The rock quarried here is known as the Burlington limestone, and is similar in character to rock of the same age which is quarried in Adams, Pike, and Greene counties. It is a massive, gray, coarsely granular limestone which contains scattered nodules and irregular layers of chert indiscriminately distributed throughout.

In quarrying the rock is blasted down in benches 16 feet high. Ingersoll Rand tripod drills are used in drilling and 40 per cent dynamite is used in blasting.

The broken rock is hand-loaded into small cars which are pulled to and up the tipple to the crushers by cable. The crushing machinery consists of two crushers, an Austin No. 4 and a Gates No. 2. A 32-inch Austin screen is used in separating the different sizes. Two-inch crushed rock is the largest size product.

The product is used for agricultural limestone, road material, railroad ballast, and whiting. The daily production is about 150 tons, but the plant has a capacity of 175 tons. Bins provide storage for 300 tons.

POSSIBLE SHIPPING QUARRY SITES

Because limestone occurs near the railroad only along the Mississippi River bluff between Grafton and Piasa Creek, any new quarries would have to be located there. Of the rocks comprising the bluff, only the Niagaran dolomite and Keokuk-Burlington limestone are thick enough and free enough from shale to warrant consideration as sources for road material. The Niagaran dolomite is prominent in the bluff for about a mile east of Grafton, and the Burlington limestone makes up the bluff in the vicinity of Elsah and to the east.

K No. 82

The bluff between Grafton and the quarry operated by The Columbia Quarry Company probably offers the best site for additional quarries. The rock face is more than half a mile long and about 40 feet high, and is covered by 10 to 30 feet of loess. The rock is Niagaran dolomite and is similar to that at the quarry of the Columbia Quarry Company.

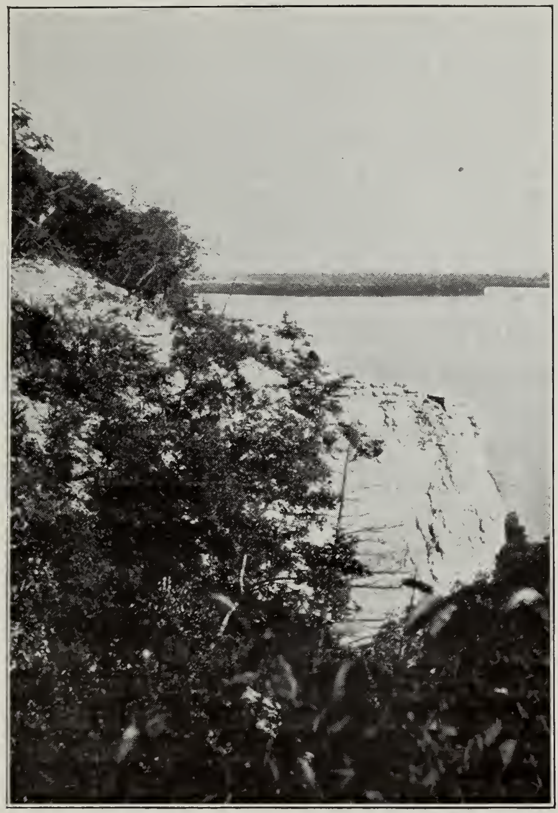

Fig. 44. Burlington limestone in the Mississippi River bluff near Elsah.

However, several hundred feet back from the bluff the thickness of the loess probably averages almost 25 feet. Along most of the bluff the rock has been quarried back until the overburden averages 20 feet but where this is the case rock might be obtained by quarrying downward.

The amount of rock available is limited only by the depth to which rock can be profitably quarried and by the amount of overburden than can be removed.

K No. 85

Elsah area

Rock can be obtained in commercial quantity anywhere along the bluff near Elsah and eastward.

In the vicinity of Elsah the Burlington limestone (fig. 44) forms the entire bluff and more than 150 feet of limestone is available. Except where dissected by ravines, the bluff is a sheer cliff. The overburden which is loess, reaches a thickness of 50 feet in places, but a strip from 50 to 150 feet wide is available with less than 15 feet of overburden. In most places the proximity of the bluff to the railroad affords no space for plant buildings, but by utilizing the ravines which interrupt the bluff almost every half mile, this difficulty may be overcome.

East from Elsah the shales and shaly limestones of the overlying formations make up the upper portion of the bluff and prevent extensive quarrying into the bluff. However, large quantities of rock could be obtained by quarrying the narrow strip along the edge of the bluff where the overburden is absent or very thin.

In addition to the transportation facilities afforded by the Chicago, Peoria, and St. Louis Railroad, it is also possible to utilize Mississippi River which flows close to the bluff throughout this region.

OUTCROPS OF LOCAL IMPORTANCE

Outcrops of stone for local use may be obtained from the bluffs of Illinois River and along the lower courses of most of the creeks which empty into the Illinois or Mississippi.

MADISON COUNTY

The bed rock of Madison County (fig. 45) is composed of the sandstone, shales, or thin limestones of Pennsylvanian age, except for the area of Mississippian limestones north and west of and in the immediate vicinity of Alton. Almost everywhere the underlying rocks are obscured by a mantle of drift or loess which reaches a thickness of more than 80 feet in places and averages about 40 feet. As a result the bed rock is visible only along the streams where the overlying covering of drift and loess has been eroded.

SHIPPING QUARRIES

There are at present only two shipping quarries in this county, both in the vicinity of Alton, though in times past four others were operated in and about the city. Of the two in operation, one is located in the river bluff and the other on top of the bluff.

FIG. 45. Map of Madison and St. Clair counties showing location of quarries and quarry sites.

L No. 60

Mississippi Lime and Material Company

Until recently four quarries were operated in the Mississippi River bluff in secs. 10 and 11, T. 5 N., R. 10 W., near Alton, by the Armstrong Lime and Quarry Company, the Alton Lime and Cement Company, the Lockyear Quarry Company, and the Gissal Stone Company. These four quarries have now been combined by the Mississippi Lime and Material Company into one large quarry with an open face about a mile long, which varies from 60 to 80 feet in height.

The overburden consists of brown loess and ranges from 10 to 60 feet in thickness. It averages about 45 feet. It is removed by washing into nearby flat land by a stream of water under pressure.

The quarry face is worked in three or four benches, varying in height from 10 to 25 feet. Air drills are used for making the blast holes and 40 per cent dynamite for shooting down the rock. The broken rock is loaded by hand into 5-ton steel quarry cars which are pulled by locomotives to an elevator which conveys the rocks to the primary crusher. The primary crusher is a No. 7½ gyratory and the secondary crushing battery consists of two No. 6, one No. 5 and two No. 3 gyratories. Two No. 36 American pulverizers are used for producing the finer crushed stone. Sizing of the quarry product is accomplished by three cylindrical screens. Storage is provided by a bin of 600 tons capacity.

The daily production of the plant is from 1000 to 1200 tons. The yearly production is about 175,000 tons.

Transportation is provided by the Chicago, Peoria and St. Louis Railroad which runs along the foot of the river bluff.

The rock being quarried is the St. Louis limestone. It is fine-grained, gray to white in color. Some of it is burned for lime, but the bulk of the quarry product is used for road material, concrete aggregate, and agricultural limestone.

L No. 61

Reliance Quarry and Construction Company

The quarry of the Reliance Quarry and Construction Company is located in the city of Alton near Sixteenth and Bell streets. Unlike previously described quarries, it is not located along the bluff but on top of it. The quarry face is 62 feet high and consists of massive, fine-grained, gray to white limestone. The overburden is brown loess similar to that which is present at the bluff quarries and varies in thickness from 20 to 60 feet, the average being about 40 feet. The overburden is removed by hand-shoveling into small cars which are run to a nearby dump. The Chicago and Alton Railroad, which serves this quarry takes much of this dirt for use in fills.

As in other quarries in this vicinity, the rock is quarried in benches of about 20 feet, and hand-loaded. Two steam tripod drills are used in putting down the blast holes.

Two Gates crushers, a No. 5 and a No. 3, comprise the crushing machinery. The crushed rock is screened into three sizes:—⅜-inch, ¾-inch, and 1½-inch, the first constituting 10 per cent, the second 45 per cent, and the third 45 per cent of the total product. The storage capacity is about 400 tons. The daily production is about 100 tons and the yearly production about 40,000 tons. Much of the crushed stone is ground for whiting.

POSSIBLE QUARRY SITES

L No. 59

Large quantities of limestone are available for quarrying only along the river bluff from Alton to the Jersey County line, a distance of about 6 miles. Here the bluff forms a continuous escarpment except where broken by the narrow ravines of small streams emptying into Mississippi River.

Owing to the southeast dip of the rock the thickness of limestone in the bluff decreases somewhat to the south and varies from about 80 feet near the Jersey County line to about 65 feet at Alton. The upper beds near Alton are known as the Ste. Genevieve limestone, and the lower beds are called the St. Louis limestone. The exposed thickness of the Ste. Genevieve limestone decreases to the north.

The Ste. Genevieve limestone shows a considerable variation both vertically and laterally. It is oolitic, semi-oolitic, compact, or sandy, and the strata of no two localities are identical except in so far as they may show similar variations. The limestone occurs in beds of variable thickness ranging from 3 or 4 inches to 1 or 2 feet. Vertical jointing is prominent in the thinner beds, giving them the appearance of a brick wall. The heavier beds, however, are relatively free from joints. In places a thin seam of greenish shale is found separating limestone beds, but such seams are commonly no more than a few inches thick. Some of the limestone beds are sandy and border upon calcareous sandstone. The larger portion of the rock, however, is a pure, fairly hard, gray, oolitic or dense limestone.

The St. Louis limestone is more uniform than the Ste. Genevieve. It is mainly a hard, fine-grained, compact gray limestone, some beds of which are so fine-grained that they resemble lithographic stone. On the weathered surface the rock is a chalky white. Thin shaly partings are present locally, but they are never numerous or thick enough to affect the general character of the rock. The rock varies from medium-bedded to massive, and joints are rare.

Both the St. Louis and the Ste. Genevieve limestones have been used repeatedly on roads in the vicinity of Alton and have been found satisfactory.

Tests made on the rock by the Illinois Highway Division show that the rock fulfills the specifications for road material and is of high quality for agricultural use.

The overburden in Madison County consists of fine wind-blown silt called loess. In places it extends to the very edge of the river bluff where it stands with a vertical face 30 feet or more in height. At other places, the rock has been uncovered for a distance of about 15 feet back from the edge of the bluff, whence the loess again rises rapidly to its average height. Narrow ravines have been cut in the loess so that the surface is broken and irregular. All these factors cause the overburden to vary greatly from place to place, so that for small areas the thickness of overburden may vary from nothing to 60 feet. However, if areas of several acres are considered, the average thickness of the overburden is about 40 feet.

At the present time the local demand for crushed rock is well supplied by quarries already operating in this vicinity. However, should the demand for crushed rock increase, it is very probable that one or more large quarries could be opened along the Mississippi River bluff.

The greatest drawback would be the amount of overburden which must be removed. If an average depth of 40 feet of overburden is assumed and 70 feet of rock made available, it would be necessary to move about .57 yards of overburden for every yard of rock in place. The great thickness of overburden is to some extent compensated by the conditions which make its removal comparatively easy. The proximity of the bluffs to the river makes it possible to wash the overburden directly into the river so that no handling, transportation, or dumping area is required.

Some of the advantages of this area are the favorable transportation facilities, the large quantity, and the high quality of the rock available.

The Chicago, Peoria, and St. Louis Railroad runs along the foot of the bluff so that shipping facilities are easily obtainable.

On account of its purity, compactness, and the massive character of some of the beds, the rock lends itself to many uses besides road material and concrete aggregate. Much of the stone when burned makes a very high grade lime; some makes excellent whiting; and almost all of it can be pulverized for agricultural limestone that will analyze from 94 to 96 per cent calcium carbonate. The crushed rock is used in concrete construction, and some of the heavier beds could be used for building stone.

As much of the land near the bluff is unfit for agriculture, acreage could be procured more cheaply than would otherwise be possible.

LOCAL SOURCES OF LIMESTONE

Along Silver Creek in the SW. ¼ SW. ¼ sec. 33, T. 5 N., R. 5 W., near the town of Grantfork, there is an area of about two acres underlain by a 3-foot bed of dense, gray, Pennsylvanian limestone. The overburden is a gray clay soil, and varies in thickness from 2 to 8 feet, with an average of about 3 feet. Rock from this outcrop has been used to construct a macadam road from Grantfork to Highland.

The amount of crushed rock available at this locality would not greatly exceed 10,000 yards. However, with a portable crusher, rock for culverts, bridge foundations, or road repairs could be obtained.

A thin limestone bed outcrops at a few other places along Sugar and Silver creeks, but the thickness of the overburden makes profitable quarrying impossible.

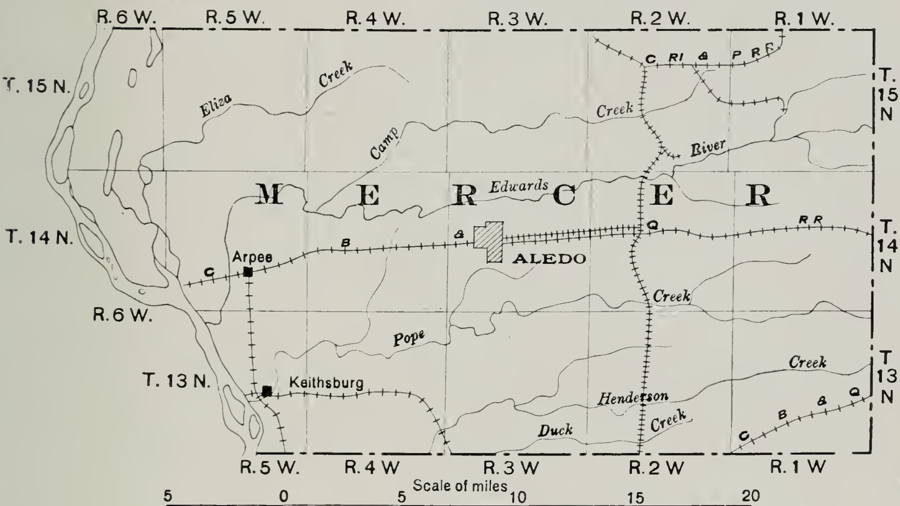

Fig. 46. Index map of Mercer County.

MERCER COUNTY

The following outcrops of Pennsylvanian limestone are reported in Mercer County (fig. 46) :

1. Secs. 3, 4 and 5, T. 14 N., R. 2 W. Ten to fifteen feet of gray or drab limestone in thin beds.
2. Sec. 34, T. 15 N., R. 2 W. The stone is similar to the preceding.
3. Two feet of blue limestone is commonly found above the most important coal seams of the county.

Mississippian limestones belonging to the Kinderhook group are reported to outcrop in sec. 5, T. 13 N., R. 5 W., in the bluff at the junction of Edwards and Mississippi rivers.

MONROE COUNTY

The rocks which outcrop in Monroe County (fig. 47) are of Mississippian age except those at and around Valmeyer, where limited exposures of Ordovician and Devonian rocks occur, and in the northeast and extreme northwest corners of the county, where the Pennsylvanian sandstones and shales immediately underlie the surficial material.

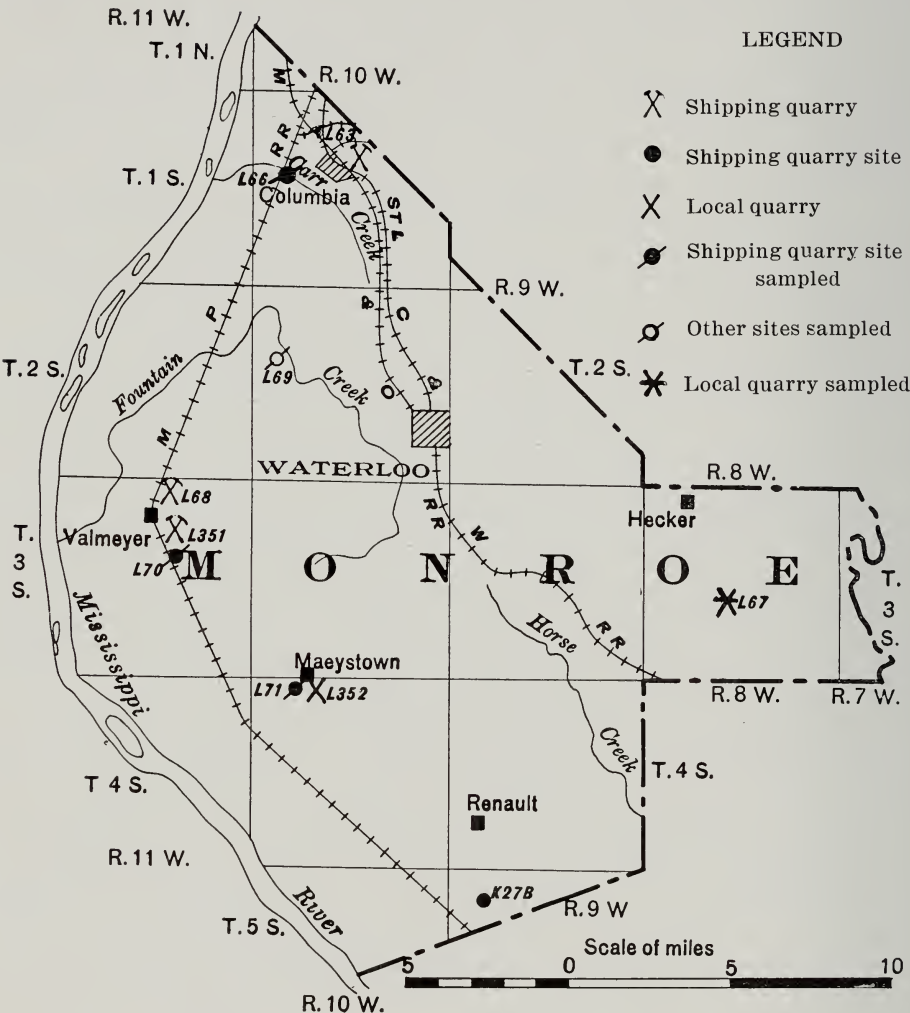

FIG. 47. Map of Monroe County showing location of quarries and quarry sites.

Although the bed rock is covered by a thick mantle of drift or loess in most places, it is commonly exposed along nearly all stream courses and in the rims of numerous sinks. Particularly is this true of the Mississippian limestones, which, where easily accessible, will furnish practically unlimited quantities of stone.

There are three shipping quarries located in this county; one near Columbia on the Mobile and Ohio Railroad, and the other two in the river bluff at Valmeyer.

SHIPPING QUARRIES

L No. 63

Columbia Quarry Company

Quarry No. 2

The quarry east of Columbia is situated in a hill in the SW. ¼ SW. ¼ sec. 14, T. 1 S., R. 10 W. It has a face about 600 feet long and 55 feet high which is being worked back into the hill.

The rock quarried is known as the Salem limestone and is essentially a compact, fine-grained, gray limestone containing small lenses and nodules of chert in the upper beds. The limestone breaks with a subconchoidal fracture. The thinner beds are badly jointed, but the heavier and more massive beds are relatively free from fracture planes. A section of the rock is as follows:

	Thickness *Feet*
4. Limestone, thin bedded with nodules of chert	8
3. Limestone, massive, blue-gray with specks of crystalline calcite	14
2. Limestone, thin-bedded, somewhat soft and cherty	12
1. Limestone, massive, compact, gray with specks of crystalline calcite.	20
Total	54

The overburden consists of brown loess which varies in thickness from 10 to 50 feet and averages about 15 feet. It is removed by loading it into cars with a steam shovel and hauling it with a locomotive to nearby ravines.

A well drill is used to drill the blast holes which are shot with 40 per cent dynamite. The broken rock is then hand-loaded into small cars and hauled by mules to the incline where a hoist pulls the car to the primary crusher. Masses of rock too large to load by hand are further broken up by "dobie" or "block hole" shots.

The primary crusher is a No. 8 K Allis-Chalmers gyratory, and the secondary battery a No. 6 K Allis-Chalmers and a No. 4 Austin. Sizing is accomplished by means of two screens:—a 48 inch by 24 foot Gruendler and a 36 inch by 16 foot Stephens Adamson.

The daily production is about 900 tons and the yearly production about 100,000 tons. Bins provide storage for about 200 tons.

The quarry product is used as aggregate, road material, agricultural limestone, and as flux, particularly in aluminum refining.

L No. 68

Columbia Quarry Company

Quarry No. 3 at Valmeyer is located in the river bluff in the NE. ¼ SW. ¼ sec. 3, T. 3 S., R. 11 W. The rock from this quarry is produced exclusively for use in the refining of aluminum, and for other fluxing purposes. The average daily production is about 1400 tons and the yearly production about 140,000 tons. Transportation is furnished by the Missouri and Pacific Railroad.

The quarry face is 700 feet long and 135 feet high. The overburden of yellow loess ranges in thickness from 15 to 65 feet; and averages about 35 feet. It is loaded into cars by a steam shovel and dumped into an adjacent hollow.

The rock which is known as the Kimmswick limestone is a coarsely crystalline, massive bedded stone with but few joints. Ten feet of soft, cherty, gray limestone separates the upper 65 feet of massive gray limestone from the lower 60 feet of pinkish heavy-bedded stone. The following section is exposed in the quarry:

	Thickness *Feet*
3. Limestone, massive, coarsely crystalline	65
2. Limestone, soft, cherty, gray	10
1. Limestone, heavy-bedded, crystalline with a pinkish tinge	60
Total	135

In quarrying, a row of holes is drilled with well drills through the upper 65 feet; this part of the face is then blasted down; next the 10-foot cherty layer is broken up; and finally the bottom 60 feet are shot down. Forty per cent dynamite is used in the blasting operations.

The broken rock is loaded by steam shovel into quarry cars, which are drawn to the crushers and emptied by a derrick. Any masses of rock which are too large to handle are further reduced in size by "dobie" or "block hole" shots. The crushing apparatus consists of No. 12 K and No. 6 Allis-Chalmers gyratories. Two screens, an Allis-Chalmers 5- by 20-foot cylindrical and a 6-foot Tyler shaker, are used to size the crushed stone.

An immense amount of stone is available here, but with the exception of the cherty layer, is too soft to serve as road material. The stone is however, admirably suited for agricultural and chemical uses due to its high degree of purity.

L No. 351

The Valmeyer Limestone and Stone Company

This quarry is located a little south of Valmeyer in the NW. ¼ sec. 10, T. 3 S., R. 11 W. The working face of the quarry is located high on the river bluff and the crushing plant at the base of the bluff, thereby making the utilization of gravity in the crushing operations possible.

The rock which is quarried is the Salem limestone. It is a medium-grained, dense, buff and gray-white stone, and contains locally large nodules of chert. As the nodules are large enough to be separated easily from the surrounding limestone the product can be made free from chert if so desired.

The rock is blasted down in benches, and hand-loaded into quarry cars, which are run to the edge of the quarry floor and dumped into steel lined chutes. Gravity carries the rock down the chutes to the primary crusher which is a McCully. The broken rock is sized by two cylindrical screens 5 by 10 feet and 5 by 18 feet respectively, and the oversize further reduced by a Worthington crusher and a 36- by 16-inch roll. The stone can be produced in practically any sized fragments desired.

The crushed stone is sold locally and shipped on the Missouri and Pacific Railroad.

LOCAL QUARRIES

L No. 352

Columbia Quarry Company

Quarry No. 5

The Maeystown quarry is located in a hill in the NW. ¼ SW. ¼ sec. 5, T. 4 S., R. 10 W., about three-fourths of a mile due south of the town of Maeystown.

The stone quarried is the St. Louis limestone. It is a dense, fine-grained, hard, brittle, blue-gray rock in regular beds of medium thickness. The overburden is about three feet of clay and is removed by loading into a wagon and dumping into a nearby ravine.

A 35-foot face of rock about 400 feet long is being worked. A well drill is used to make the blast holes and the stone is shot down with 40 per cent dynamite. It is hand-loaded into wheelbarrows and thus conveyed to the crusher, an Austin No. 4 gyratory. A flat wire screen, a No. 36 American pulverizer, and a bin holding 100 tons constitute the remainder of the quarry equipment.

The quarry is without railroad shipping facilities and transportation is effected by means of trucks and wagons. The daily production is about 100 tons and the yearly production about 6000 tons. It is being operated as a local source of agricultural limestone and road material.

POSSIBLE QUARRY SITES

Monroe County is traversed by only two railroads:—the Missouri Pacific and the Mobile and Ohio. The Missouri Pacific runs along the river flat near the foot of the bluff, for the entire length of the county. The Mobile and Ohio enters the county at the northwest corner, follows a general southeasterly direction, and leaves the county at the southeast corner. A branch runs eastward from Millstadt Junction in the northwest corner of the county. Shipping quarries are therefore restricted to the river bluff or to a narrow strip diagonally southeast across the county.

The region along the Mobile and Ohio Railroad

There are two quarries operating along the region traversed by the Mobile and Ohio, one about one mile east of Columbia and a second on the branch about two miles east of Millstadt Junction, just over the St. Clair County line. These quarries are capable of supplying any demand likely to arise in this region.

South of Columbia no outcrops of importance were observed within a mile of the railroad except at Andys Run in the west-central part of sec. 14, T. 2 S., R. 10 W. where the rock outcrops along the creek for several hundred feet. However, the area of exposed rock is less than two acres and the overburden rapidly reaches a thickness of 25 feet on each side of the stream. Furthermore, the railroad passes 25 feet above the outcrop, which would make transportation a difficult problem. Likewise, a pit quarry would be subject to flooding from the stream. These factors together with the competition from the more favorable situated quarries make this locality of doubtful value. No other exposures of importance occur along this railroad and although limestone forms the bed rock at many places, it is covered by 20 to 50 feet of drift and could be quarried only by working a pit.

The region along the Missouri Pacific Railroad

The Missouri Pacific Railroad follows along the base of the Mississippi River bluff for its entire length in the county. At places the railroad is about a mile and a half from the bluff, but is commonly near enough to make a switch feasible.

The amount of stone available in the bluffs is practically unlimited and good quarry sites are numerous. The most favorable locations for quarries are in the Mississippi River bluff from Morrison Hollow south to the county line; from Monroe City Hollow north to a point slightly beyond the quarry at Valmeyer (fig. 48) and from Trout Hollow north to Fountain Gap. At these places the bluffs are composed mainly of Salem and St. Louis limestone and stand as sheer cliffs 90 to 200 feet high. In the remainder of the bluff, the slopes are relatively gentle and the rock is concealed by talus and loess, (fig. 49). Where such bluffs consist of the Warsaw formation, as from Chalfin Bridge to Monroe City Hollow, they contain local beds of shale.

The foot of the bluff is commonly concealed under a covering of talus which may extend from a quarter to half way up the face of the bluff and have a width of from 50 to 200 feet.

The bluff is capped by loess which reaches a thickness of 75 feet or more in some places, and locally rises abruptly from the edge of the bluff in a steep face. In general, however, there is a 10- to 15-foot strip along the edge, where there is little or no overburden, but beyond which the loess rises to its regular height.

At intervals the bluff is broken by small creeks emptying into the Mississippi, and it is at the intersection of these creeks with the bluff that the most promising quarry sites are to be found. K. No. 27 B represents a typical case.

Fig. 48. The Mississippi River bluff south of Valmeyer. The upper medium bedded rock is the St. Louis limestone and that below the Salem limestone.

K. No. 27 B

About a mile north of the Randolph County line the bluff is broken by a small creek. A narrow ravine leading to the creek runs parallel to the face of the bluff and gives rise to a narrow ridge about half a mile long and about 200 feet wide at the top. Toward the river the ridge presents a sheer face, and on the side toward the ravine the surface slopes rather steeply. The top of the ridge for the first 1,500 feet from the southeast end is practically bare, but beyond this the loess rises rapidly. The talus accumulation at the foot of the bluff is practically negligible. The ravine will make an excellent dumping ground for the overburden whenever stripping becomes necessary.

The ridge rises to a height of 200 feet, where the loess becomes prominent, but it averages probably 120 feet. This ridge, 1,500 feet long, more

FIG. 49. The two types of bluff along Mississippi River south of Valmeyer. In the upper figure the bold bluff is composed of the St. Louis and Salem limestones. In the lower figure the gently sloping bluff is composed of the shale and shaly limestone of the Warsaw formation.

than 200 feet wide, and 120 feet high, would yield over a million cubic yards of rock with the necessity of practically no stripping.

The rock comprising the ridge is known as the St. Louis and the Salem limestone. It is mainly a compact, hard, gray limestone, though the Salem limestone does contain some beds of crystalline or granular limestone. These, however, are so well cemented that they serve quite satisfactorily as road material.

The ridge is about 1 mile from a railroad, but the intervening country is flat and presents no obstacles to the construction of a spur.

SAMPLES SECURED

Five samples of the stone taken at various places along the bluff or a short distance back from it, are as follows:

L No. 66. Ste. Genevieve limestone in the nose on the north side of Carr Creek where it intersects the bluff about 1½ miles west of Columbia.

L No. 68. Kimmswick limestone at the quarry three-fourths of a mile northeast of Valmeyer.

L No. 69. St. Louis limestone in the cen. of the north line, NE. ¼ sec. 18, T. 2 S., R. 10 W.

L No. 70. Salem limestone in the NW. ¼ SE. ¼ sec. 15, T. 3 S., R. 11 W.

L No. 71. St. Louis limestone half a mile south and a little west of Maeystown.

DEPOSITS OF LOCAL IMPORTANCE

A list of all limestone outcrops which might furnish rock for local use is practically impossible. Nearly every creek and hollow within three miles of the bluff exposes limestone along its course, and near the bluffs the valley slopes show almost as great a thickness of rock as do the bluffs. Furthermore, rock is exposed in many of the sink holes scattered over the western and southwestern parts of the county. Especially is this true at some distance from the bluff, where the loess is thinner.

In the eastern half of the county where the Upper Mississippian (Chester) sandstones, limestones, and shales comprise most of the bed rock, limestone exposures are not so numerous. Descriptions of a few typical localities where either Upper or Lower Mississippian rocks are exposed, follow.

Sec. 14, T. 2 S., R. 10 W.

For about 1,200 feet the flood plain of Andys Run in the SW. ¼ NW. ¼ of sec. 14, T. 2 S., R. 10 W., consists of hard, gray, compact Ste. Genevieve limestone, overlain by less than 5 feet of overburden. The overburden is composed of brown clay and rises rapidly on both sides of the creek to a thickness of about 25 feet. The exposure, however, is narrow and occupies less than two acres. At a similar exposure several hundred feet farther east on the north fork of the creek the rock outcrops for 10 to 15 feet along the bank, but is overlain by 25 to 30 feet of clay soil. Only about 1½ acres have less than 5 feet of overburden.

These outcrops are probably capable of supplying the immediate neighborhood with all the stone it may need. Because of its proximity to the Mobile and Ohio Railroad it might be considered a favorable location for a shipping quarry, but it is open to certain objections which are stated in discussing the area along the Mobile and Ohio Railroad.

L No. 67

Thirteen feet of limestone is exposed along the banks and flood plain of Prairie du Long Creek in the west-central part of sec. 21, T. 3 S., R. 8 W. The overburden reaches a thickness of 30 feet at a short distance from the outcrop, except over a strip about 150 feet wide and 600 feet long, where it is probably less than 10 feet.

The rock is a coarsely crystalline, moderately hard, gray limestone, and is a part of the Okaw formation. A 2½-foot shale bed is found 8 feet from the top, and it is very probable that other shale beds occur below. Though only 13 feet of limestone is exposed, the thickness of the bed is probably considerably greater. More than 50,000 tons can be obtained here.

Sink holes

It is very doubtful if any great quantity of rock is available at any one sink hole, because the overburden commonly rises rapidly from the edge of the rock to heights which prohibit its removal. Many of the sink holes can yield more than 1,000 tons of rock, and for localities where railroad transportation is wanting, enough stone might be quarried to build all local roads.

PIKE COUNTY

Practically all of Pike County (fig. 50) except the north central part is underlain by limestones and shales of Lower Mississippian age. Over most of this area, however, the rock is buried beneath great thicknesses of drift or loess, and it is only along stream courses that rock is available at the surface. The best exposures of rock are found along the Illinois River bluffs and along streams close to the bluffs. The Mississippi River bluff as far south as Atlas shows shale in its lower portion and only a relatively thin capping of limestone. Near the south end of the county, however, limestone of Silurian age appears along the base of the bluff.

The rock outcrops are numerous. Rock is quarried only near Pearl in the southeast corner of the county where the Chicago and Alton Railroad operates a quarry for ballast and aggregate.

SHIPPING QUARRY

K No. 106

SW. ¼ sec. 10, T. 7 S., R. 2 W.

Quarry of the Chicago and Alton Railroad [1]

This quarry which produces about 300 yards of crushed rock daily is located in the bluff. It is 450 feet long and has a face 110 feet high. The overburden consists of loess and averages about 8 feet in thickness.

The rock quarried is known as the Burlington limestone. It is a massive, gray, coarsely granular limestone, characterized by abundant chert which occurs as thin irregular layers and nodules. The rock is very similar to that at Quincy in Adams County, and that at Eldred in Greene County, and may be expected to give similar results in tests.

In quarrying, rock is blasted down in about 30-foot benches. Ingersoll-Rand drills are used in putting down the holes and 60 per cent dynamite is used in blasting.

[1] In 1924 the Chicago and Alton Railroad informed the Survey of its intention to abandon this quarry. The description of the quarry is included as a matter of record.

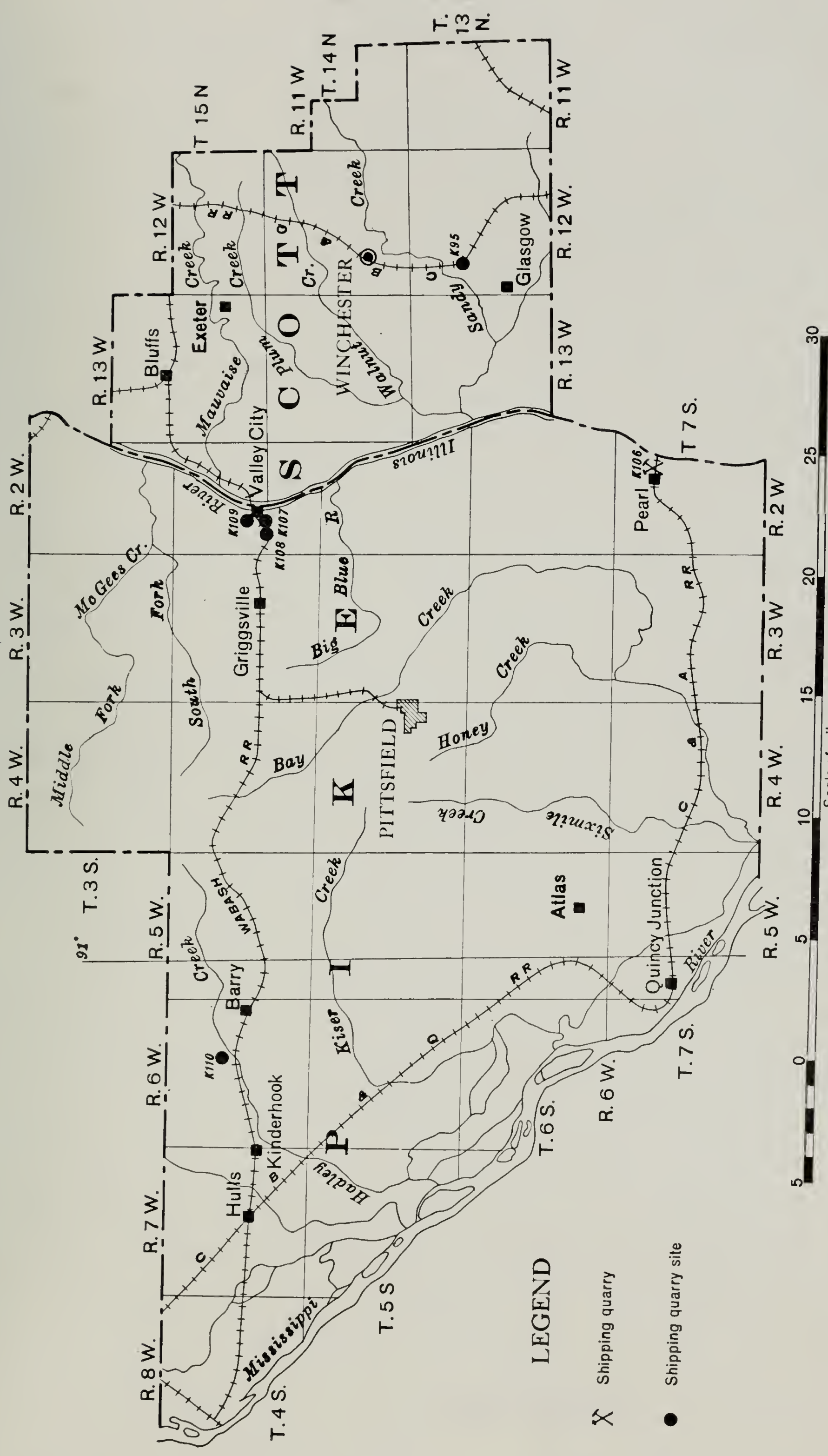

FIG. 50. Map of Pike and Scott counties showing location of quarries and quarry sites.

The broken rock is loaded by hand into 2-yard cars and hauled to the crusher by horses. The crushing machinery includes two Gates crushers, a No. 6 and a No. 5. The sorting is done by a 42-inch screen.

POSSIBLE QUARRY SITES

The more favorable localities at which rock is available near a railroad are at Valley City and along Hadley Creek northwest of Barry.

At all of these places the rock is the massive, gray, coarsely granular limestone similar to that which is quarried at Pearl. It is probably too soft to make good road material. It can, however, be used as aggregate in concrete which is not subjected to wear and its high degree of purity when free of flint makes it desirable for lime manufacture, for agricultural limestone, and for other uses which demand a pure limestone.

K No. 107

An abandoned quarry is located along the railroad in sec. 20, T. 4 S., R. 2 W. about one-quarter of a mile southwest of Valley City. The quarry face is 200 feet long and 50 feet high. The overburden consists mainly of loess and averages about 15 feet in thickness.

The bluff continues westward along the railroad for about one-quarter of a mile and though the slope is comparatively gentle, yet a quarry face could be developed without much difficulty. The distance the quarry could be worked back into the bluff depends on the amount of overburden that could be removed profitably, but for more than 150 feet back from the edge of the bluff, the overburden would not average much over 10 feet.

K No. 108

Along Creek west of Valley City

For more than a mile westward from Valley City the creek bluffs show more than 30 feet of rock. The stream meanders greatly and its bluffs approach the railroad at intervals as ridges. The thickness of the overburden on many of these ridges is less than 5 feet and as many are several hundred feet wide, large quantities of stone might be obtained here. The Wabash Railroad runs along the base of the bluff.

K No. 109

Bluff north of Valley City

The bluff immediately north of Valley City might also be considered as a possible quarry site. The bluff is 50 to 70 feet high and is covered by loess which increases in thickness from almost nothing at the edge of the bluff to 30 feet or more, several hundred feet back from the edge. The bluff is within 800 feet of the Wabash Railroad.

K No. 110

Hadley Creek area

Several localities in the bluff along Hadley Creek may furnish large quantities of rock where the bluff parallels the Wabash Railroad northwest of Barry. Probably the most favorable location is in the SE. ¼ sec. 15, T. 4 S., R. 6 W., about 2½ miles northwest of Barry. Here an area of more than 5 acres is available with less than 15 feet of overburden. The bluff which is about 400 feet north of the railroad presents a steep slope for a distance of more than 800 feet, and over an area 300 feet wide along the top the overburden is less than 8 feet thick. The top of the bluff is 140 feet above the flat. The flat bottom land between the railroad and the bluff would furnish adequate space for the erection of a crushing plant.

ROCK FOR LOCAL USE

Rock for local use may be obtained anywhere along the bluffs of Mississippi or Illinois rivers, and along the lower courses of all the creeks which empty into these rivers.

RANDOLPH COUNTY

The topography of the northern and eastern parts of Randolph County (fig. 51), is flat or only gently rolling, and the bed rock, which is concealed beneath a mantle of clay till 10 to 40 or more feet thick, is exposed only along a few streams. In the southern and western parts, however, especially in the area bordering the river bluffs, the country is considerably dissected, and rock outcrops along nearly every ravine and hollow. In the Mississippi River bluffs thicknesses of more than 100 feet of rock are commonly exposed.

Except in the northeastern part of the county, where rock of Pennsylvanian age is found, and in the northwestern part where St. Louis limestone of Lower Mississippian age comprises the bluff, the bed rock of the county consists of a series of interbedded limestones, sandstones, and shales of Upper Mississippian age.

The river bluff is the only place in the county where large quantities of rock are available within reasonable distance of a railroad, so that any new shipping quarries in the county would have to be located there. Rock for local purposes can be obtained along many of the creeks and ravines in the western and southern parts of the county.

SHIPPING QUARRY

There is only one shipping quarry in the county and that is the prison quarry at Menard (fig. 52).

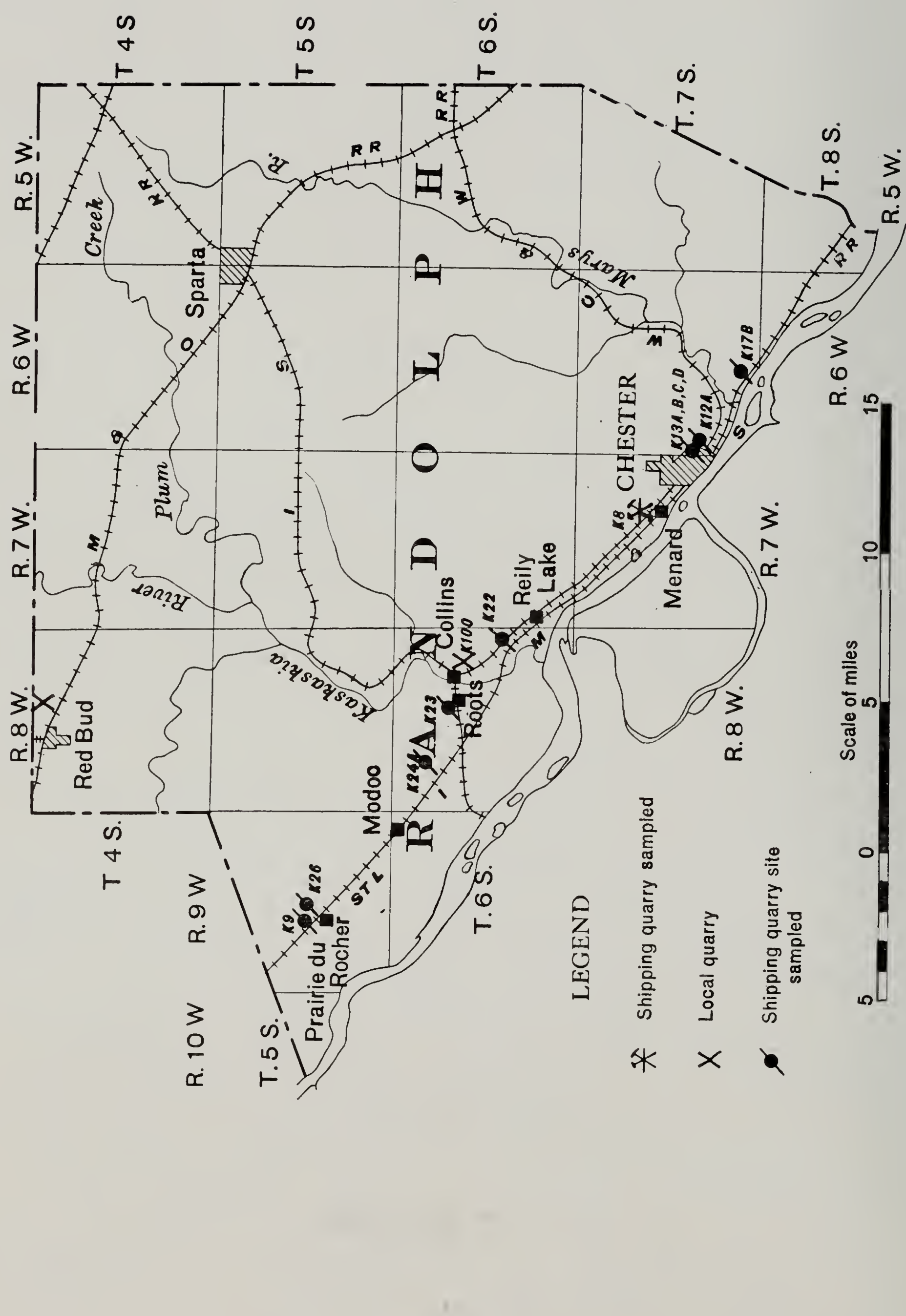

Fig. 51. Map of Randolph County showing location of quarries and quarry sites.

K No. 8

Sec. 28, T. 7 S., R. 7 W.

Penitentiary quarry at Menard

Practically all the rock quarried here is used for agricultural limestone, and as road material.

Two quarries are operated one inside and the other outside the prison yard. At both quarries a 40-foot face of rock is worked. The rock within the prison yard is almost free of shale but that outside the prison where slightly higher beds are quarried contains much interbedded shale.

The limestone in both quarries is a coarsely granular rock of Upper Mississippian (Okaw) age and when free from shale is of a high degree of purity. In general, the limestone layers which are interbedded with shale are less pure than those which are free from shale.

Fig. 52. The inside quarry at the Southern Illinois Penitentiary at Menard.

The overburden at the inside quarry reaches a thickness of 38 feet and consists of loess and limy shale. At the outside quarry the overburden is also loess, but it is probable that on working back additional shale beds will be found coming in above the present quarry face.

Similar quarry methods are employed at both quarries. The overburden is loaded into wagons by hand and hauled away by teams. The rock is shot down in benches of 14 to 16 feet. Steam drills are used for making the blast holes and 40 per cent dynamite used in blasting.

The crushing machinery at the inside quarry consists of an Austin No. 7½ crusher and a No. 9 Williams pulverizer. At the outside quarry a Gates No. 7½ crusher is used in crushing the rock.

Practically all of the rock from the inside quarry is used for making agricultural limestone, and the stone produced from the outside quarry is crushed for road material.

The yearly production from both quarries is approximately 45,000 tons.

POSSIBLE SITES FOR SHIPPING QUARRIES

Probably the best location for a large shipping quarry in this region is the river bluff from the Monroe County line to a point about 1½ miles south of Prairie du Rocher. The bluff throughout this distance except for the gap at Prairie du Rocher presents a steep face of solid rock which is about 200 feet high at the county line but thins to the south and is probably not more than 100 feet high south of the gap. The rock is St. Louis limestone of Lower Mississippian age, and is similar to the St. Louis of St. Clair County except that chert is a little more common in the upper layers. It is a compact, fine-grained rock, gray to white in color and massive in structure. Locally it has been burnt for lime, and chemical analyses of some of the beds show more than 95 per cent calcium carbonate.

The greatest drawback to this region is the amount of overburden present. The edge of the bluff is usually bare, but the loess begins 5 or 10 feet back from the edge, and in less than 50 feet reaches a height of 60 to 100 feet and averages about 80 feet.

Although the slopes of loess have been dissected into a series of narrow ridges, the ravines are usually so narrow that they do not decrease greatly from the amount of overburden. Even if some economical means of removing such a thickness of overburden could be found, there would then be the problem of finding suitable dumping area. For supplying a temporary demand, it is very probable that several hundred thousand tons of rock could be procured by quarrying a strip from 10 to 15 feet wide over a considerable distance along the bluff.

K No. 9

Sample K No. 9 was taken at a small quarry in the bluff about half a mile north of Prairie du Rocher Creek and represents in a general way the St. Louis limestone as it occurs in that region.

K No. 26

Prairie du Rocher

Probably the best location for a quarry in this region would be on the west side of Prairie du Rocher Creek, about three-quarters of a mile north of Prairie du Rocher. At this place the cliff has a short westward projection which terminates in a flat area comprising 500 square feet, the surface of which is more than 100 feet lower than the surface of the adjoining bluff. The south face of this projection is about 1,000 feet long at the base, and reveals a thickness of 150 feet of limestone. The horizontal distance from the bottom of the hill to where the rock is covered is about 300 feet. Above this the land continues to rise and in the next 200 feet reaches a height of 60 feet above the exposed rock in the terrace. To the north of the flat there is also a steep slope and the overburden can be dumped here as it is removed from the flat. On the west side of the flat the slope is gentle and all rock is covered by loess which is 30 feet thick at the road. Though the loess appears to be from 50 to 60 feet thick, it is very probable that some has been washed down over the upper beds of rock so that it is possible that the overburden does not average much over 30 feet.

The amount of rock available in this area is more than 2,000,000 cubic yards.

Transportation facilities might be obtained by continuing the spur of the Missouri Pacific, which at present extends only as far as the Brickey Lumber Company's storage sheds.

Other bluff regions

K Nos. 22, 23, and 24A

Southeast of the Prairie du Rocher region to a point about two miles beyond Modoc, the bluff is composed mainly of sandstone, but beyond this, as far as the city of Chester, the bluff consists almost entirely of the Okaw formation.

The Okaw formation is mainly limestone, but contains some interbedded shale ranging in thickness from less than an inch to 10 feet or more. The limestone is essentially a coarsely crystalline to granular rock, but appears well cemented and may make satisfactory road material. Some chert bands or nodules are present but are not common.

Sample K No. 24A was taken from the ravine in the Mississippi River bluffs half way between Roots and Modoc; K No. 23 from the large hill just northwest of Roots; and K No. 22 from the bluff near the center of sec. 24, T. 6 S., R. 8 W., about 1¼ miles northwest of Reily Lake. These samples are all taken from the Okaw limestone and indicate the general character of the more strictly calcareous portions of this formation.

K Nos. 12A, 13A, 13B, 13C, 13D, and 17B

From Chester south to Marys River, the bluff is also mainly limestone, but the upper beds are known as Menard. The Menard is generally a fine-grained, compact, blue-gray limestone occurring in 4- to 12-inch beds, although some beds of granular limestone may be found in the formation. Nodules and irregular layers of chert are common. A 25-foot bed of sandy shale is present near the base. Except near the base, the shale occurs mainly as thin bands interbedded with the limestone, giving rise to the relatively gentle slopes which characterize this formation. South of Marys River the bluffs consist mainly of sandstone.

Unlike the bluffs composed of Lower Mississippian limestones which rise directly from the flat with only a small amount of talus, the bluffs composed of these Upper Mississippian limestones are usually found from 200 to 600 feet from the flat. The gentle slope which rises 30 to 60 feet above the flat and which may be from 100 to 300 feet wide, is generally heavily timbered. The slope suddenly increases sharply for 50 or 200 feet more and thence the cliff rises 10 to 40 feet higher. The top of the talus slope is commonly more than 100 feet above the flat. Above the rock exposed in the bluff the loess rises to heights of 60 feet and more. From the vicinity of Chester south to Marys River, the limestone is capped by sandstone in addition to the loess.

Sample K No. 12A was taken from the Menard limestone in the valley near the center of sec. 30, T. 7 S., R. 6 W.; K No. 13A from the Okaw limestone and K No. 13 B, K No. 13 C, and K No. 13 D from the Menard limestone in the valley at the south end of Coles Mill in the NW. ¼ sec. 30, T. 7 S., R. 6 W.; and K No. 17 B from the Menard limestone in the river bluff southeast of Ford in sec. 33, T. 7 S., R. 6 W.

LOCAL SUPPLIES OF LIMESTONE

One mile North of Collins

On the east side of Okaw River, just south of Ninemile Creek, a face of rock 300 feet long and about 30 feet high is found 50 to 100 feet east of the Illinois Southern Railroad. The overburden of loess rises rapidly from the edge of the face until it reaches a thickness of 35 feet, after which it continues to rise with a gentle slope until the level of the bordering highlands is reached.

The rock is a granular or semi-crystalline limestone, very similar in appearance to that quarried at the Menard penitentiary. Probably about 3,500 cubic yards of rock is available with less than 15 feet of overburden.

K No. 100

One mile south of Collins

Small quantities of rock may be obtained along the river bluff at the east side of the Okaw River gap, where an area about 100 feet wide and several hundred feet long has only a few feet of soil overburden. The rock is about 15 feet above the flat and the upper 5-foot ledge is now being quarried for agricultural limestone. The Illinois Southern Railroad, which runs along the foot of the bluff, has built a side track here. A small portable Jeffry pulverizer is used to crush the rock.

K No. 17 B

SE. ¼ sec. 33, T. 7 S., R. 6 W.

Along this bluff in this locality a 12-foot face of massive, gray, granular rock parallels the Missouri Pacific Railroad at a distance of approximately 15 feet. The exposure is about 1,000 feet long. The rock is bare near the edge, but farther back is covered with talus and soil. However, for a distance of 25 feet it is probable that the overburden does not reach a thickness of more than 5 feet. About 10,000 cubic yards are available here under these conditions.

OTHER LOCALITIES

In addition to the ravines immediately adjacent to the bluff, rock for local use can be obtained in the western and central parts of the county. Some of the most important localities are as follows:

1. Along the creek from the NE. cor. sec. 8, T. 4 S., R. 8 W., to sec. 4 of the same township, about 8 feet of gray granular limestone is exposed along the stream.

2. About 8 feet of coarsely crystalline to granular limestone is also exposed along the creek near the north line of sec. 17, T. 4 S., R. 8 W. The rock here has an overburden of 2 feet for a width of 50 feet, but beyond that, the overburden rises rapidly to 10 feet and more.

3. Similar limestone also outcrops along the creek just west of Red Bud in the SW. ¼ sec. 5, T. 4 S., R. 8 W. where the rock is quarried intermittently for local use.

ROCK ISLAND COUNTY

DESCRIPTION OF ROCK FORMATIONS

The bed rock over most of Rock Island County (fig. 53) is sandstone and shale of Pennsylvanian age. Only over a limited area in the vicinity of Rock Island, Moline, and Milan, and along the Mississippi River bluff between Port Byron and Cordova are there any limestones which may be considered possible sources of stone to be used as road metal.

The limestone in the vicinity of Rock Island and Moline is of Devonian age. It is somewhat variable in the upper portion, and includes much shaly limestone. The lower portion, however, is pure limestone, practically free from shale. This rock is best exposed and most easily accessible in the Mississippi River flat between the towns of Rock Island and Moline and between Sears and Milan along Rock River.

The rock exposed between Port Byron and Cordova is of Niagaran age and is a porous, heavy-bedded, brown dolomite.

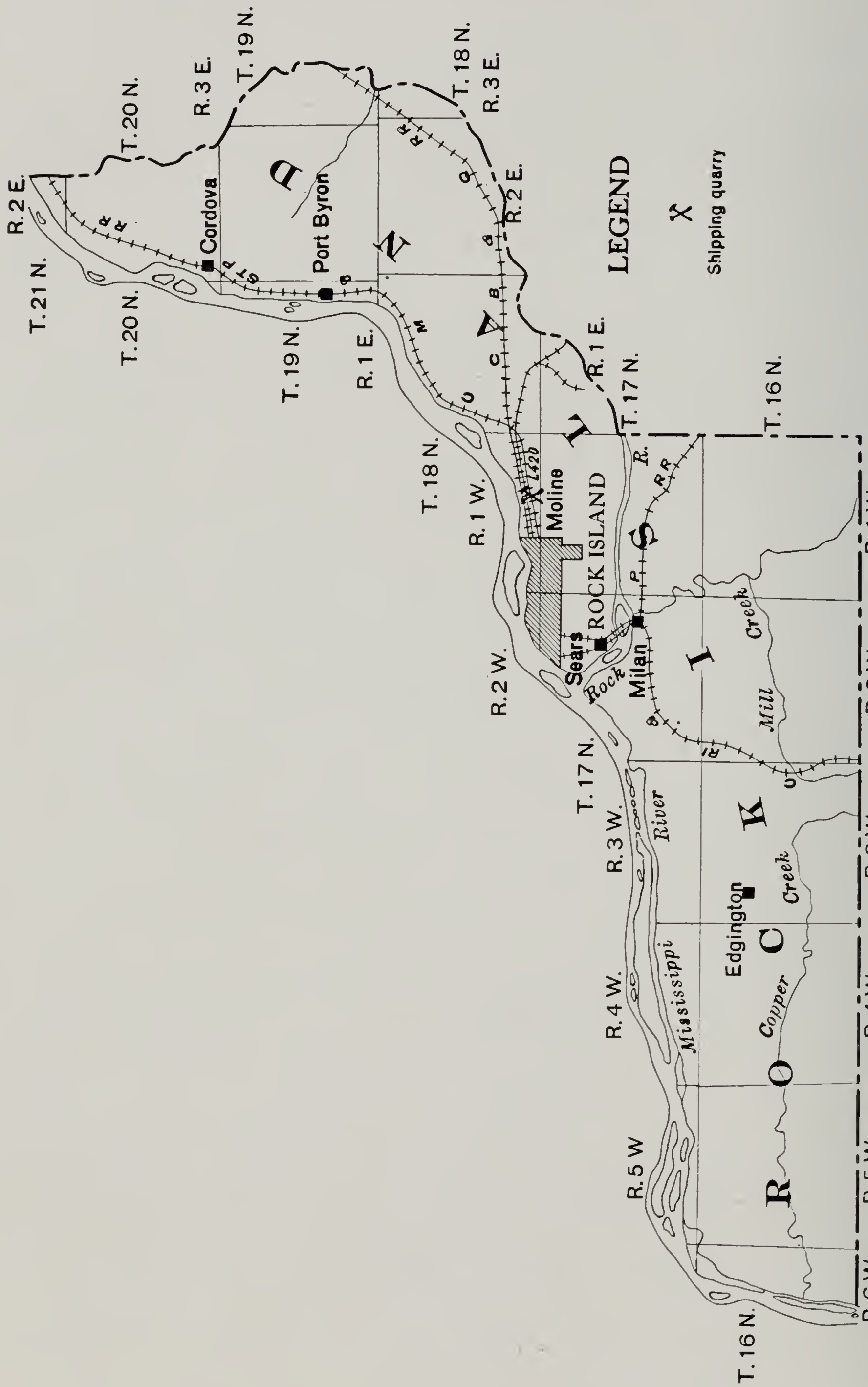

FIG 53. Map of Rock Island County showing location of quarry. Scale, 1 inch equals 7 miles.

SHIPPING QUARRY

L No. 420

The Bettendorf Stone Company

The quarry and mine of the Bettendorf Stone Company is located in the flat at the base of the Mississippi River bluff in sec. 34, T. 18 N., R. 1 W., on the eastern outskirts of the town of Moline. Until recently the quarry has been operated as a pit, but as it was worked back into the bluff the overburden became so great that it could not be removed economically, and the limestone is now secured by mining. At present the entry has been worked back into the bluff about 150 or 200 feet and three main rooms begun. A breast 24 feet high is worked by driving the upper 11 feet and then shooting down the lower 13 feet. The holes for blasting are drilled with water Leyner drills operated by compressed air, and 40 per cent dynamite is used for blasting down the rock.

The broken rock is loaded by hand into 1½-yard skips which rest on trucks, and are pushed out of the mine to beneath the boom of a steam derrick by which the skips are lifted and dumped into a bin. When the bin is full the contents are run over a grate with 3½-inch openings. The oversize is run into cars, and that passing the grate to a No. 5 Austin crusher and then to the screening battery consisting of a 3½- by 18-foot cylindrical screen with ¾-inch, 1½-inch and 2-inch mesh, and a shaker screen with ¼-inch mesh. With the exception of the hoist the plant is operated by electricity.

The mine is dry and the only precaution necessary is to pump out the sump made from the old quarry pit occasionally to prevent flooding by rainwater.

The daily production of the quarry is about 150 tons. The mine can be operated continuously through the year. Bins provide storage for 900 tons of crushed stone.

The stone is of Devonian age, probably the Wapsipinicon limestone, and is a fine grained, dense, yeast-colored, semi-lithographic rock, in beds one to five feet thick. The material which does not pass the grate is sold for flux and to the sugar refineries and carbide works. The stone which does pass the grate is sold for aggregate, road material and agricultural limestone.

Transportation is furnished by the Chicago, Burlington and Quincy and Chicago, Milwaukee and St. Paul railways, which pass close to the quarry property.

POSSIBLE SHIPPING QUARRY SITES

The region offering the best possibilities for shipping quarry sites is the flat along the Mississippi between Moline and Rock Island. Throughout this area the lower part of the Devonian limestone comprises the bed rock with only a thin overburden. However, as most of this area is occupied by buildings and railroads, places where rock may be quarried without interfering with existing structures are few.

Somewhat similar conditions are to be found along Rock River between Sears and Milan.

The Niagaran dolomite which outcrops between Port Byron and Cordova is exposed at the base of several gently sloping hills. The hills have a heavy covering of drift and loess which increases in thickness towards the tops of the hills.

Transportation facilities could be provided by the Chicago, Milwaukee and St. Paul and Chicago, Rock Island and Pacific railroads for the flat in the vicinity of Rock Island and Moline. The area between Sears and Milan could be served by the Chicago, Rock Island and Pacific Railroad, and that between Port Byron and Cordova by the Chicago, Milwaukee and St. Paul Railroad.

SCOTT COUNTY

There is only one locality in this county (fig. 50, p. 237) where rock may be obtained easily accessible to a railroad. Rock for local use, however, may be obtained at many places in the western half of the county.

POSSIBLE SHIPPING QUARRY SITE

K No. 95

At the railroad cut, NE. cor. sec. 18, T. 13 N., R. 12 W.

Rock was formerly quarried 2 miles north of Glasgow by the Chicago, Burlington and Quincy Railroad. The quarry is located at the end of a low broad ridge, is about 100 feet wide, and has been worked back about 100 feet. The quarry face shows 20 to 25 feet of massive, coarsely granular limestone of Burlington age which contains numerous layers and nodules of chert. The upper several feet of rock is badly weathered.

The overburden of loess is 5 to 8 feet thick near the quarry, but increases gradually back from the face. The ridge is several hundred feet wide and for about 200 feet back has less than 15 feet of overburden. The rock is of Burlington age, and is similar to that quarried in Greene, Pike, Adams, and Jersey counties, and may be expected to give similar results in tests.

OUTCROP MAINLY OF LOCAL IMPORTANCE

Large quantities of limestone for local use may be obtained from the outcrop of Burlington limestone in the river bluff near the south line of the county, along the streams in the vicinity of Glasgow, and north of the road near center of sec. 8, T. 13 N., R. 12 W.

Other outcrops of limestone which may be of value for local purposes are found along Mauvaise Creek in the NE. ¼ sec. 26, T. 15 N., R. 13 W., near Exeter and also along the creek in the vicinity of Bluffs.

About half a mile south of Winchester in the SE. ¼ sec. 29, T. 14 N., R. 12 W. there is exposed in an abandoned quarry along the west side of Sandy Creek about 18 feet of fine-grained, gray limestone. The rock is of St. Louis age and is in beds 3 inches to 2 feet thick. Thin layers of green shale often separate the different beds.

The overburden of drift and soil reaches a thickness of 5 feet near the quarry edge but becomes thicker back from the face. An area of about one acre is still available with less than 10 feet of overburden. Other outcrops of this limestone are found along the bank both north and south of the old quarry.

ST. CLAIR COUNTY

Most of the bed rock outcrops of St. Clair County (fig. 47, p. 223) consist of the sandstones, shales, and thin limestones of Pennsylvanian age. However, an area in the western part of the county from Stolle south to the Monroe County line and extending a little farther east than the west line of Millstadt Township, is underlain mainly by Lower Mississippian limestones, and at a few localities in the southern part of the county, Upper Mississippian rocks are encountered.

These rocks are almost everywhere buried under a mantle of drift or loess to a depth which varies from less than 20 feet to more than 100 feet, and it is only along the streams or on the hillsides that bed rock is exposed.

Only in the area underlain by the Mississippian rocks is the limestone thick enough to warrant the removal of the overburden present, and it is here that existing quarries are located and that any new quarries of importance must also be located. It is probable, however, that some rock for local use may be obtained where the thin limestones of Pennsylvanian or Upper Mississippian age outcrop along the streams.

SHIPPING QUARRIES

There are four quarries operating in the area underlain by the Mississippian limestones, three along the river bluff between Falling Spring and Stolle, and one in a hillside near the Monroe County line.

L No. 62

SE. ¼ sec. 10, T. 1 S., R. 10 W.

Columbia Quarry Company[1]

Quarry No. 1 operated by the Columbia Quarry Company about 1½ miles north of the town of Columbia is the largest in southern Illinois. The

[1] Quarry No. 1 of the Columbia Quarry Company was destroyed by fire in 1924. A strictly fireproof plant including a washer for small sizes is now in course of construction.

average daily production is about 3,400 tons of crushed stone, and the yearly production about 700,000 tons.

The quarry is located in a hill and is 1,280 feet long, 550 feet wide, and has an 85-foot face. Below the main quarry floor there is also a smaller pit about 1,200 feet long with a face about 40 feet high. The overburden is a yellow-brown loess averaging about 15 feet in thickness. It is loaded into cars by steam shovels and dumped into nearby ravines.

In quarrying, the entire 85- or 40-foot face is shot at one time. The holes for the blasting are drilled with well drills, and 40 per cent dynamite is used. The broken rock is loaded by steam shovels into 4-yard side dump cars and hauled to the tipple by locomotives. The cars are pulled up to the crusher by a cable. The primary crusher is a No. 18 N Allis-Chalmers gyratory. The second battery is composed of a No. 8, two No. 5s, and a No. 3 Allis-Chalmers crushers, and two No. 36 American pulverizers.

The screening apparatus includes one 60-inch and two 48-inch cylindrical Gates screens, and three "whip-tap" shaker screens. By changing the screens any size up to 5-inch can be obtained, but in general the product consists of about 15 per cent dust, 10 per cent of ½-inch, 10 per cent of ⅞-inch, 10 per cent of 1½-inch, 25 per cent of 2-inch, and 30 per cent of 5-inch. The bin storage capacity is about 800 tons. The rock has been used extensively both in waterbound macadam roads and as aggregate in concrete roads.

The quarry is served by the Mobile and Ohio Railroad, the crushed rock being used mainly in the southern part of the State and to some extent in Missouri, Kentucky, and Tennessee.

K No. 3

Casper Stolle Quarry and Construction Company

The Casper Stolle Quarry and Construction Company operates a quarry in the river bluff near Stolle in sec. 14, T. 1 N., R. 9 W. for which the Illinois Central Railroad affords the transportation.

The 70-foot quarry face is about 1,500 feet long, and extends into the bluff for about 400 feet. The overburden, which is loess averaging not more than 10 feet in thickness, is removed by wheel scrapers. In quarry practice about thirty 6-inch holes of the full depth of the face are drilled with a well drill, about 15 feet apart and a like distance from the face. The whole face is then blasted down, with 40 per cent dynamite and any masses that are too large for the steam shovel to handle are reduced by further blasting. Jack-hammer drills are used for the drilling of the secondary blast holes. The broken rock is loaded by a steam shovel and two revolving shovels into 4-yard quarry cars and hauled to the tipple by a locomotive Here a cable is attached, and the cars are drawn to the crushers.

The crusher plants are two in number, the one at the south end of the quarry containing a No. 8 Gates crusher connected with a No. 5, and the second plant, which is about 500 feet north containing No. 6 and No. 8 Gates crushers, five 40-inch by 20-foot Gates cylindrical screens which separate the rock into different sizes and an American pulverizer for fine crushing. The rock most commonly obtained is classified as dust, ⅜-, ⅞-, 1¼-, 1½-, 2-, and 2½-inch. More than 50 per cent of the rock is over 2 inches, the sizes from ⅞- to 1½-inch represent 30 per cent, about 5 per cent is ⅜-inch, and about 15 per cent is dust.

The storage capacity of the plant is 30 carloads in bins and ground space for 65,000 yards. About 40 per cent of the product of this quarry is sold as railroad ballast, and the remainder is used as agricultural limestone, road material, and aggregate in concrete.

The capacity of the quarry and plant is about 1,500 tons and the daily production about 800 tons. The yearly production is 120,000 tons.

K No. 5

East St. Louis Stone Company

The quarry operated by the East St. Louis Stone Company is located in the river bluff in sec. 14, T. 1 N., R. 9 W. about half a mile northeast of Falling Spring. It is served by the Terminal Railroad. The production is about 450 tons per day.

The quarry is about 600 feet long, extends into the bluff for 300 feet, and has a face 65 feet high. The overburden consists of loess which varies in thickness from 12 to 25 feet, but averages about 18 feet. Stripping is done with steam shovel; the overburden is transferred to railroad cars by chutes and used by the railroad for fills.

In quarrying, the rock is blasted down in benches of about 18 feet. The blast holes are drilled by Ingersoll Rand steam-drills about 10 feet from the edge of the face and about the same distance apart. The broken rock is loaded by hand into small cars and pushed as far as the track of the Terminal Railroad which separates the crusher from the quarry floor. It is then picked up by a derrick which lifts it over the railroad track and is dumped into the crusher.

The crusher used is a No. 6 Gates gyratory. After being crushed, the rock is elevated to a cylindrical screen and sorted into the following sizes: —dust (less than 3/16-inch), 3/16- to ⅞-, ⅞- to 1¼-inch, and 1¼- to 2-inch. Larger sizes are furnished on demand. The oversize is returned to the crusher. Sixty per cent of the product is from 1½ to 2 inches in size, 25 per cent from 3/16 to 1¼ inches, and about 15 per cent is dust. The storage capacity is limited to a strip of ground 800 feet long and 13 feet wide.

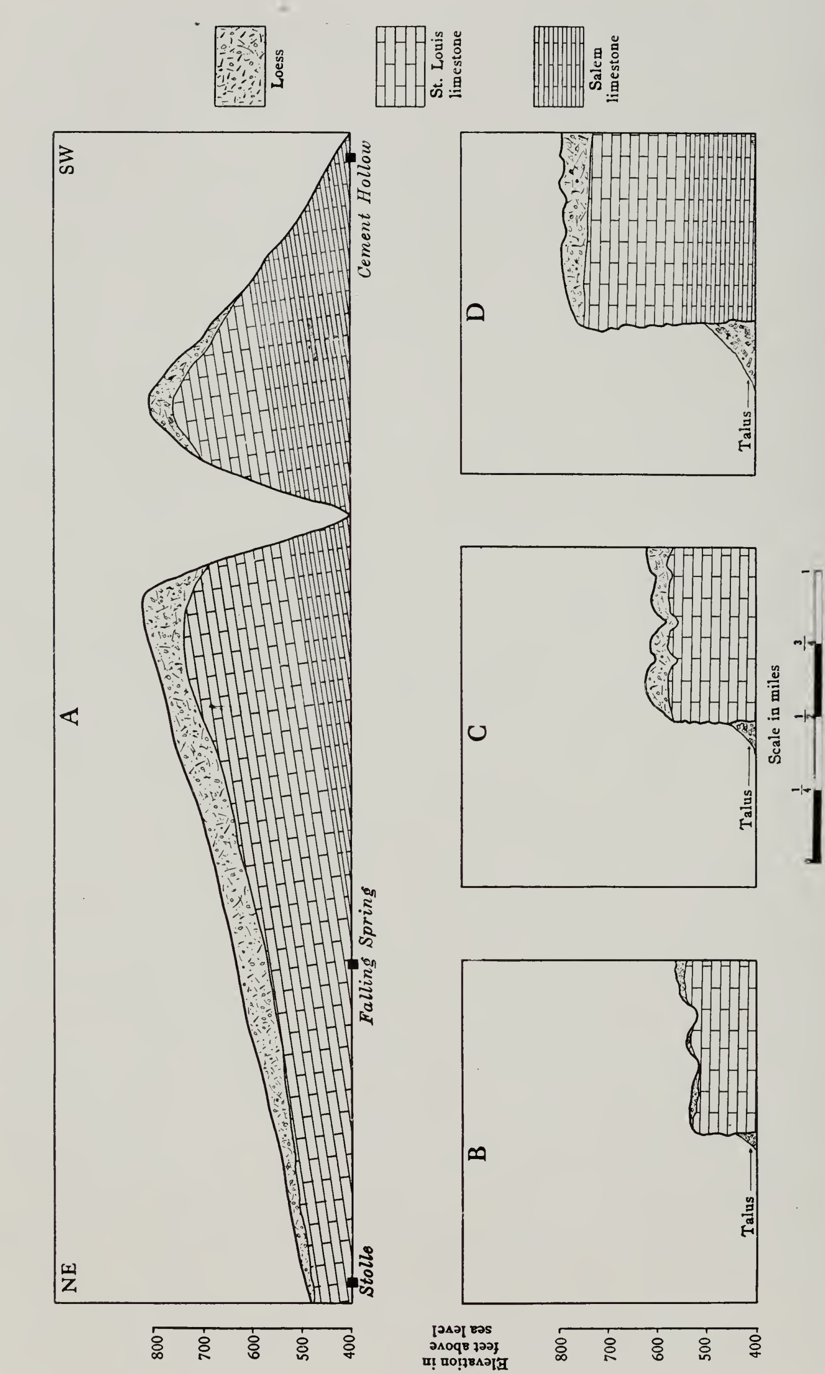

FIG. 54. A. Longitudinal section along the Mississippi River bluff from Stolle to Cement Hollow. B. Cross-section of bluff at Stolle. C. Cross-section at Falling Spring. D. Cross-section at Cement Hollow.

About 40 per cent of the output from this quarry is used for railroad ballast, and the remainder is used as agricultural limestone, road material, and aggregate for concrete.

T. W. Stolle Quarry

A quarry operated by T. W. Stolle is located on the river bluff about half a mile south of Falling Spring. Owing to the thickness of the overburden, which is as much as 40 feet in places, this quarry is used only to supply riprap for railroads and rubble for building foundations, and is worked only intermittently. All drilling is done by hand, and black powder is used in blasting. A No. 3 Gates crusher with boiler, elevator, and screen is installed here but is not in operation.

POSSIBLE QUARRY SITES

K No. 4

The most favorable locations for new quarry sites in this region are along the river bluffs from Stolle south to within a mile of the Monroe County line (A, fig. 54). The bluff of solid limestone, which first becomes prominent immediately north of Stolle, continues without a break southward, its height increasing from less than 60 feet at Stolle (B, fig. 54) to about 115 feet near Falling Spring (C, fig. 54), and 250 feet near the county line (C, fig. 54).

The loess, which caps the bluffs everywhere along the Mississippi, has an average thickness of less than 10 feet at Stolle but increases toward the south, and at Falling Spring reaches nearly 30 feet. The surface back from the bluff is level or only gently rolling and rises slowly to the south. Near the edge of the bluff, however, the surface of the ground generally slopes steeply to meet the rock. For short distances, however, a strip of rock 10 to 15 feet wide is bare near the edge of the bluff, although elsewhere the loess may reach the very edge with almost vertical slope. Rain wash has given rise to small ravines which add to the irregularity of the loess near the edge of the bluff. Therefore, if a small strip along the bluff only several hundred feet wide is considered, the amount of overburden may vary from 10 feet or less to more than 30 feet. However, where large areas are considered the overburden will average at least 20 to 50 feet and possibly more. The foot of the cliff is hidden beneath a talus which consists of blocks of limestone intermingled with soil and loess and covered by timber. The height of the talus slope varies, but generally extends a fourth or even a half of the way to the top of the bluff. Above the talus the limestone presents a sheer face of massive rock. Wherever observed the rock surface beneath the loess was found to be fairly level.

The rock comprising the bluffs is known as the St. Louis limestone, but since the rock dips to the north, it is very possible that some of the lower strata of the bluff north of Cement Hollow may belong to the Salem limestone. As exposed at the quarries of the East St. Louis Stone Company and the Casper Stolle Quarry and Construction Company, it is essentially a hard, compact, and fine-grained, gray limestone. Some of the beds are locally so even grained and compact that they resemble lithographic stone. Near the top of the section there is 4 feet of green-gray calcareous sandstone in 4- to 8-inch layers. Some of the lower limestone beds at the Casper Stolle quarry have a sandy texture, are yellow-gray in color, and are in places separated by thin partings of green shale. Chert as small nodules and thin lenticular layers occurs below the sandstone, but this cherty layer is probably not continuous. It was not observed at the East St. Louis quarry. A section of the East St. Louis Stone Company's quarry follows. It is very similar to that at the Casper Stolle quarry.[2]

	Thickness *Feet*
4. Limestone, massive, lithographic	4
3. Sandstone, green-gray, calcareous	4
2. Limestone, massive, gray, somewhat sandy at top	4
1. Limestone, compact, gray, mainly thick bedded or massive	56
Total	68

Owing to the increase in the height of the rock toward the south, the exposed thickness at any given locality would depend on its position along the bluff. The increase in the elevation of the top of the bluff from 60 feet above the bottoms at Stolle to about 115 feet at Falling Spring, a distance of a mile, gives a rate of rise amounting to about 60 feet to the mile. The total thickness of suitable rock is probably nowhere less than 200 feet.

The rock from quarries already located along the bluff has been tested by the Highway Division and has been found satisfactory. As shown by chemical analyses of the different strata the calcium carbonate content may vary from 81 to as much as 95 per cent, the average composition of the dust being slightly more than 90 per cent. It therefore makes very acceptable agricultural limestone. Its purity, massive character, hardness, and close texture will permit the rock to be used for many other purposes besides road material or concrete aggregate.

The amount of rock available in this region is practically unlimited, each acre being capable of yielding approximately 300,000 yards of crushed rock above drainage level.

[2] Below (1) in the section at Casper Stolle quarry there is 7+ feet of yellow dolomite rock.

If it is feasible to remove 40 or 50 feet of overburden this region would be a most promising one in which to locate new quarries because of the high quality of the rock and the large quantity available.

At present the Terminal Railroad runs along the foot of the bluff only from Falling Spring to within a short distance south of Stolle, but very probably a spur could be built to localities along the bluff that are south of Falling Spring. The flatness of the bottoms at the foot of the bluff would make the building of a spur relatively simple, for no costly grading would be required. As the Terminal Railroad has connections at East St. Louis with many railroads, the crushed rock could be shipped almost anywhere in the State, so far as transportation facilities are concerned.

The absence of ravines along most of the bluff where the overburden could be disposed of, makes necessary a search for a dumping ground along the foot of the bluff. Fortunately, several low places exist there, some of which contain swamps. The largest place is located about a mile south of Falling Spring and comprises more than 40 acres. Probably the most economical way of removing the overburden would be to use hydraulic methods and wash it into such low places. Water for this purpose could be obtained from a nearby marsh, or shallow wells. The loess might also be removed by loading with steam shovel or drag line and transferring down to waiting railroad or dump cars by means of chutes.

Belleville city quarry
K No. 5A

There is a small quarry within the city of Belleville which is operated in connection with the county jail. The rock quarried is about 10 feet thick, but only the upper 4 feet is fairly pure limestone. The lower beds vary in composition from a sandy limestone to a calcareous sandstone. Most of the rock is hard and well cemented, and makes acceptable aggregate for concrete where there is no wear. The amount of stone available here is small, and owing to the overburden which is 8 feet thick in places, it is doubtful whether rock could be quarried profitably under ordinary circumstances.

OTHER SOURCES OF LIMESTONE

There are several localities where rock can be obtained in small amounts, which might be of interest providing small portable crushers are available.

SE. ¼ NW. ¼ sec. 10, T. 2 N., R. 7 W.

Here a 4-foot bed of massive, compact, red-gray limestone outcrops for 300 feet along the creek. The overburden rises rapidly away from the creek bank and in many places reaches a thickness of 15 feet, less than 30 feet from the edge of the stream. The amount of rock available without stripping is probably less than 500 yards.

Along Silver Creek, 2 miles southeast of Freeburg

In secs. 27, 28, 33, and 34, T. 1 S., R. 7 W., a ledge of limestone 8 to 10 feet thick outcrops at several places. The outcrops are discontinuous and are from 50 to 200 feet long. The overburden increases rapidly away from the bank, but for a strip from 25 to 50 feet wide, the average thickness would be less than 10 feet. At the southeast corner of sec. 28, where the rock is exposed along a tributary, there are several acres where there is less than 3 feet of cover. The rock is a compact, fine-grained, gray limestone. The upper beds are thin, but toward the bottom the rock becomes more massive. The amount of rock available would not be much less than 50,000 yards. However, as the Illinois Central Railroad runs within 3 miles of these localities, it may be more convenient to ship in crushed stone.

Sec. 15, T. 2 S., R. 9 W.

In the east-central part of sec. 15, T. 2 S., R. 9 W., a similar rock outcrops along a branch of Kopf Creek and also in the nearby slope. Here, as in other creek exposures, the thickness of the overburden increases rapidly so that only a small amount of stone, probably less than 1,000 yards, is available. A small portable pulverizer was in operation when the outcrop was visited.

The above-mentioned outcrops do not constitute all the exposures in these localities but represent the most important ones.

Sec. 28, T. 2 S., R. 8 W.

In the east-central part of sec. 28, T. 2 S., R. 8 W., a ledge of limestone about 100 feet long outcrops along the slope. A thickness of 8 feet is exposed, but the rock probably continues in depth for 10 feet more. The overburden is about 5 feet thick at the outcrop, but increases to 15 feet a short distance away from the outcrop. A portable jaw crusher is located here, but is only operated intermittently to supply the local demand.

Near Floraville

About 1½ miles northeast of Floraville, in the SW. ¼ SW. ¼ sec. 6, T. 2 S., R. 8 W., the creek bank consists of a red-gray, coarsely granular limestone, which is characterized by thin, irregular, shaly partings. The outcrop is about 200 feet long, and from 8 to 10 feet of rock is exposed above the creek bed. The overburden is a red clay till, and though only about 4 feet thick near the bank of the creek, it increases rapidly in thickness in the slope. Several thousand tons of crushed rock could be obtained here. The limestone is similar in character to that quarried at the penitentiary at Menard and may be expected to give similar results in testing.

CHAPTER IX.—LIMESTONE RESOURCES OF ILLINOIS—SOUTHERN DISTRICT

By Frank Krey

The southern district (fig. 1) is composed of those counties forming the southern end of the State in which limestone outcrops are common. The counties are as follows:

Alexander	Massac
Gallatin	Pope
Hardin	Pulaski
Jackson	Saline
Johnson	Union

ALEXANDER COUNTY

Limestones suitable for use as road material are confined to the region of the Mississippi River bluffs in Alexander County. The bed rock over most of the county (fig. 60, p. 278) consists of chert of Devonian age.

This chert is quarried near Tamms, and is used rather extensively as road material. Its value for this purpose, aside from its hardness, is that it contains enough clay and iron to serve as binder so that it can be used directly as quarried, and when properly laid down it makes a very good road.

SHIPPING QUARRIES

There are no shipping quarries in the county producing limestone for use as road material.

POSSIBLE QUARRY SITES

A complete examination of all the limestone outcrops in the county was not made, the only area examined being in the vicinity of Thebes.

K No. 65

Thebes area

Sec. 17, T. 15 S., R. 3 W.

The river bluff half a mile south of Thebes is composed of limestone with a capping of Thebes sandstone which is locally as much as 40 feet thick. The thickness of limestone exposed above the railroad which runs along the bank of the river decreases to the north and south, but at its greatest exposure rises 70 feet above the railroad. The average width of the limestone exposed between the railroad and the sandstone varies, but in most places is not much over 300 feet.

The slope just south of the small creek which cuts through the bluff about half a mile south of Thebes probably offers the most advantages as a quarry site.

The rock is massive, blue-gray, coarsely granular limestone of Kimmswick age, and may be expected to give tests similar to the Kimmswick limestone quarried at Valmeyer. The rock is probably too soft for use as road material which is subjected to much wear but should prove satisfactory for aggregate in concrete. The high purity of the rock makes it desirable for use as agricultural limestone and other products demanding limestone having a high calcium carbonate content.

The amount of stone available in this region is probably limited only by the depth to which it can be quarried profitably. Transportation can be furnished by the Chicago and Eastern Illinois or by the St. Louis, Missouri and Southern railroads.

OUTCROPS OF LOCAL IMPORTANCE

Rock for local use may be obtained from the outcrops of Lower Silurian limestone in the Mississippi River bluff north of Thebes and in the vicinity of Gale.

The Silurian limestones vary in character at different localities, but they are generally fine-grained and compact, with varying amounts of chert. Thin layers of shale are found interbedded with the limestone at some localities.

GALLATIN COUNTY

In Gallatin County, limestones which might serve as a source for road materials are found only in the ridge known as Wild Cat Hills, in the southwestern part of Equality Township, which is a continuation of Cave Hill in Saline County. The formations here are faulted.

Most of the limestones exposed in this ridge belong to the Chester group, although in secs. 27 and 28, T. 9 S., R. 8 E. limestones of Ste. Genevieve age were noted. The limestones outcrop only on the lower slopes of the hills and are in most cases covered by talus from the higher sandstone ridges.

Lack of transportation, heavy overburden, and the fact that the Chester limestones are commonly interbedded with sandstone and shale, restrict the use of the rock in this county to local purposes only.

HARDIN COUNTY

Limestone suitable for use as road material is abundant in Hardin County (fig. 58, p. 267). Sites for shipping quarries are limited to a small area as the only railroad facilities in the county are those afforded by the Illinois Central which runs from Shetlerville to Rosiclare and a 3-mile branch which extends from Shetlerville to the Stewart mine. No outcrops of importance occur along the main line between Shetlerville and Rosiclare, but large quantities of limestone may be obtained along the branch line between Shetlerville and the Stewart mine. Rock is also available in quantity in the river bluffs in the vicinity of Elizabethtown and has been quarried there for use in work along the river.

SHIPPING QUARRIES

L No. 350

Golconda Portland Cement Company

The Golconda Portland Cement Company was originally interested in the manufacture of Portland cement and located its plant in the bluff along the Illinois Central Railway a few miles southwest of Golconda. Circumstances made the operation of the cement plant impracticable and in 1921 the crushing units and bins were transferred to the present site about half a mile east of Shetlerville in Rich Hill, in the E. ½ NW. ¼ SE. ¼ sec. 35, T. 12 S., R. 7 E.

The quarry is circular in shape, about 400 feet in diameter and is located in a bench of Ste. Genevieve (Fredonia) limestone in the lower slopes of the southwestern part of the hill. Only a thin accumulation of soil and talus overlies the rock and in some places is entirely absent. What little overburden is present is hand-loaded into carts and disposed of in a dump. Quarrying directly into the hill, however, would eventually necessitate the use of mining methods for obtaining the Fredonia limestone because of the presence of the immediately overlying 25 feet of sandstone, which in turn is overlain by 100 feet of limestone and shale.

The rock which is being quarried is the Fredonia member of the Ste. Genevieve limestone. It is a gray or white stone and is very commonly oolitic and occurs in massive beds.

A face 10 to 40 feet high is being worked in two benches, each from 15 to 30 feet thick. The blast holes are drilled with tripod air drills and the rock shot down with 30 per cent dynamite. It is loaded by hand into two-ton end dump cars in which it is conveyed to the primary crusher. Some of the stone is sold for riprap and as the quarry floor is higher than the railway spur, it is possible to load riprap cars by gravity from the level of the quarry floor.

The crushing battery consists of one No. 8 and two No. 5 Austin crushers, and by re-crushing the oversize and using a 6- by 24-foot Austin cylindrical screen, four sizes of stone are produced:—dust, ⅝-inch, 1½-inch and 2½-inch. The plant is operated by a Hamilton-Corliss steam engine with an O'Brien boiler. It is understood that eventually each crusher will be made an electrically operated unit.

The plant is reported to have a daily capacity of 4 cars of riprap and 4 cars of crushed stone. In 1923 about 16,000 tons of stone for railroad use, 9,000 tons of crushed stone, and 1,200 tons of agricultural limestone were produced. A bin, with a capacity of 600 tons, is used for storing the crushed stone.

The product of the quarry is used as agricultural limestone, road metal, aggregate for concrete bridge and foundation stone, and riprap for repair work along Ohio River.

Transportation is furnished by the Rosiclare Branch of the Illinois Central Railway, which makes easy shipment possible to Marion, Carbondale, Herrin and Metropolis.

L No. 427

Southern Illinois Limestone Company

The quarry of the Southern Illinois Limestone Company is located in a hillside along Ohio River about one-half mile west of Shetlerville. The quarry face is about one-fourth mile long and averages about 50 feet in height. The overburden is very thin.

The blast holes are drilled by tripod drills and dynamite used to shoot down the rock. It is loaded by hand into horse drawn carts in which it is conveyed to the crusher, a No. 7½ Austin gyratory. The stone is sized by a Good Roads Machinery screen, five by forty feet.

The crushed stone is used for aggregate, ballast, and agricultural limestone. Larger blocks are sold for riprap. The production is about 500 tons daily.

Transportation is provided by the Illinois Central Railroad.

SITES FOR SHIPPING QUARRIES

The most favorable localities for shipping quarry sites are the north slope of Rich Hill, the slopes of Melcher Hills, or along the west slopes of Wallace Branch for about a mile north of Melcher Hills.

K X

Rich Hill

Rich Hill is about three-fourths of a mile east of Shetlerville. It is separated from the uplands which form the bluffs along Ohio River by the valleys of two small tributaries of Wallace Branch. Almost circular in outline, it has a diameter of a little more than ¼ mile, and reaches an elevation of 215 feet above the railroad.

The hill is mainly limestone but a ledge of 25 to 30 feet of calcareous sandstone and some shale is present. A section of the hill is as follows:

	Thickness *Feet*
4. Limestone, gray, crystalline, partly concealed, mainly Renault......	40
3. Mainly concealed but showing occasional beds of limestone which reach a thickness of 1 to 3 feet in the upper part of section and 6 feet and more in the lower part (Lower Ohara and Shetlerville)..	56
2. Sandstone, yellow, fine-grained, calcareous (Rosiclare sandstone)....	25
1. Limestone, massive, white to gray, oolitic and semi-oolitic (Fredonia)	95

It is very probable that in many places where the rock is concealed it is shale. From a study of other outcrops of the same formation, it is inferred that at least a third of No. 3 in the above section is shale. The limestone of No. 4 and No. 3 is gray, granular, and crystalline. It is well cemented, however, into a hard compact rock. The limestone of No. 1 and the lower part of No. 3 contain many oolitic or semi-oolitic beds but these also form a tough, light-colored limestone. The sandstone of No. 2, known as the Rosiclare sandstone, appears as a buff-colored to brown, porous sandstone on weathered surfaces, but where fresh, it is a solid, light-colored rock difficult to distinguish from the adjacent limestones.

A composite sample of the limestones in the hill tested by the University of Illinois gave a French coefficient of wear of more than 10. The calcareous sandstone has not as yet been tested.

LOCATION OF QUARRY SITES

The railroad runs along the base of the south and east sides of the hill, but the lower almost perpendicular slopes are so close to the railroad that there is not sufficient space for the erection of a crushing plant. To the north, however, where a broad shallow ravine separates Rich Hill from the neighboring Melcher Hills, an excellent location for the erection of a plant is available. Furthermore, the slope on this side of the hill is gentle, not more than 10 feet in 50, so that the area underlain by the Ste. Genevieve (Fredonia limestone) is at least 30 acres.

The overburden except at the very foot of the slope, probably averages less than 6 feet and consists mainly of red clay-soil and loess.

Though a natural face is lacking, one could be developed without difficulty by quarrying back into the slope to where the rock would reach a height of 90 feet as the overlying sandstone is approached.

The thickness of rock available in this region is very great. The Fredonia limestone, in which the quarry should be located, varies from 100 to 150 feet thick. It is underlain by the St. Louis limestone, which may be as much as 350 feet thick, so that the depth to which rock could be quarried would depend only on the amount of water present and the convenience of handling rock.

Melcher Hills

Just north of Rich Hill are the Melcher Hills. These hills are higher than Rich Hill and are capped by a great thickness of sandstone. The rock exposed on the slopes, however, is the same as that in Rich Hill.

The Fredonia limestone which makes up the lower slopes is exposed as a belt about 600 feet wide, and reaches a height of about 80 feet before it is covered by the overlying Rosiclare sandstone. The rock is practically free from overburden except at the base of the slope where about 6 feet of loess cover it. Rock is obtainable from a strip about 600 feet wide and more than a quarter of a mile long.

Slopes to the north of Melcher Hills

The broad gentle slopes to the west of Wallace Branch consist almost entirely of the Fredonia limestone, capped by the Rosiclare sandstone. Locally the Lower Ohara limestone is also present.

Near Cave Spring there are more than 20 acres where the top of the slope is free from sandstone. The rock which rises about 80 feet above the valley flat is partly covered by a red clay soil which probably averages less than 4 feet in thickness.

The amount of rock available in this region is unlimited.

Fig. 55. Bluff of St. Louis limestone at Tower Rock, midway between Elizabethtown and Cave in Rock

OUTCROPS OF LOCAL IMPORTANCE

Limestone for local use may be obtained at many places from the St. Louis or Fredonia limestones which comprise the bed rock in the vicinity of the river between Rosiclare and Cave in Rock (fig. 55) and also where they outcrop in the west-central part of the county on the flanks of Hicks dome. Butts[1] in his chapter on the economic geology of Hardin County mentions Lead Hill in the western part of sec. 4, T. 12 S., R. 9 E., as a favor-

[1]Butts, Charles H., Geology of Hardin County and the adjoining part of Pope County: Ill. State Geol. Survey Bull. 41, 1920.

able locality for the erection of a local quarry. Limestone 100 feet thick is available here with very little overburden.

The Chester limestones which outcrop in the eastern and northern parts of the county will also furnish limestone for local purposes.

JACKSON COUNTY

Except for the extreme southwestern part, Jackson County (fig. 56) is underlain by rocks, mainly shales and sandstones, of Pennsylvanian age. Some limestone beds few of which exceed 3 feet in thickness are present in the Pennsylvanian rocks, but they are generally so heavily covered with drift or other rock, that only very small amounts of rock, less than 50 tons, are available at any one place. The Upper Mississippian limestones which are exposed at several places along the river bluffs and along one or two creeks which have removed the overlying Pennsylvanian rocks, can be made to yield some stone for local use. However, it is only in the vicinity of Grand Tower, where Lower Mississippian and Devonian limestones are exposed, that conditions are favorable for obtaining crushed rock in quantity.

SHIPPING QUARRIES

There are no shipping quarries located in the county, but in times past rock was quarried at the north end of Walker's Hill, where the Illinois Central Railroad obtained much of its ballast for use in this part of the State. Two localities which are capable of yielding large quantities of rock and which are close to a railroad are Walker's Hill and the "Back Bone", a narrow ridge about half a mile long which is located along the Mississippi River just west of Walker's Hill.

POSSIBLE QUARRY SITES

L No. 90, L No. 91, and L No. 92

Walker's Hill

Cen. sec. 24, T. 10 S., R. 4 W.

About half a mile north of Grand Tower near the extreme southwest corner of the county in sec. 24, T. 10 S., R. 4 W., there is an isolated ridge known as Walker's Hill (fig. 57). It is about half a mile long and a quarter of a mile wide. The south end rises gradually from the surrounding flat, but the north end terminates as a sheer bluff more than 50 feet high. Rock was once extensively quarried here for railroad ballast, but recently only small amounts have been quarried to meet local demands. The quarry face is about 400 feet wide and 53 feet high. The overburden of soil and loess reaches a thickness of 33 feet at the crest of the hill, but thins rapidly to the sides, and on the slopes of the hill is so thin that the underlying rock outcrops at intervals. For the width of the quarry face the overburden

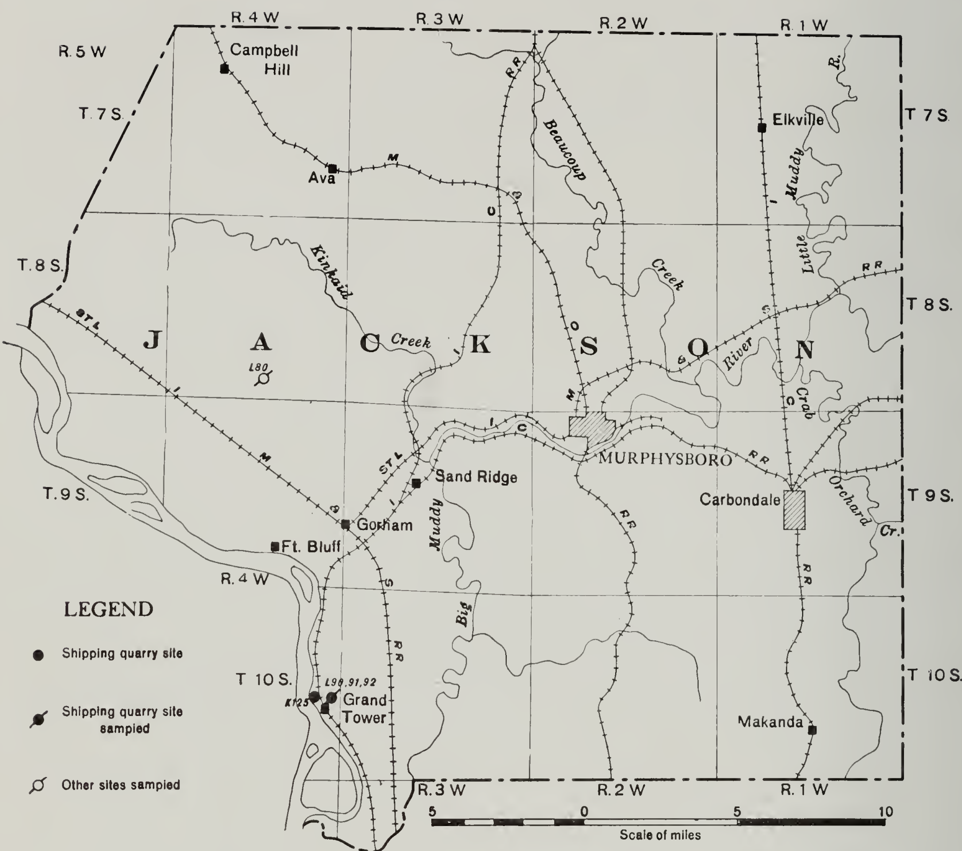

FIG. 56. Map of Jackson County showing location of quarry sites.

FIG. 57. The quarry in the south end of Walker's Hill near Grand Tower. (L 90, 91 and 92 in fig. 56.)

probably averages 20 feet. The rock dips about 30 degrees to the northeast and the quarry face at the end of the hill is at right angles to the strike of the rock.

The rock in the quarry belongs primarily to the Salem formation, and is mainly a heavy-bedded or massive, compact, mostly fine-grained, hard, gray limestone. Chert in thin seams and irregular nodules is common in some beds. Several vertical fractures occur at the west end of the quarry face, but none are found at the east end. Tests made on samples from this locality show the rock to be well suited for road material.

The rock outcrops along the sides of the hill for about 2,000 feet, suggesting that at least 10 acres are available. Furthermore, the quantity of rock obtainable might be increased by continuing in depth until groundwater level is reached.

Elsewhere in the hills favorable sites for quarries may be found especially on the northeast side where the overburden is thin. Due to faulting near the southeast end of Walker's Hill a variety of formations are exposed, including the St. Louis and Salem formations, the Osage group and the Devonian limestone.

The present quarry is being operated by McCann Brothers of Murphysboro whenever there is a local demand for crushed rock. A portable crusher made by the American Wheel Scraper Company, and a dismantled tripod drill were the only equipment seen. The screen is 10 feet long and has ¼- and 1¾-inch perforations. The sized product is discharged into a bin having a capacity of almost 30 cubic yards.

The problem of railroad transportation offers no difficulties. The Illinois Central Railroad runs within half a mile of the quarry and the old railroad grade, built when the rock was used for ballast still remains, though tracks and ties have been removed.

K No. 125

The "Back Bone"

The "Back Bone" is a narrow ridge about half a mile long which is situated along the Mississippi River just north of Grand Tower. This ridge presents a steep slope toward the river and a more gentle one away from the river. The maximum width of the ridge occurs at the south end where its base is about 1,000 feet wide. Towards the north end of the Back Bone near the line separating sec. 23 and sec. 24, T. 10 S., R. 4 W. a roadway has been blasted through the ridge which is less than 500 feet wide at this point.

The "Back Bone" consists wholly of limestone and contains only a thin capping of loess at its crest. The slopes are practically free from overburden except for fallen blocks and fragments and a covering of thin soil.

At its highest point the ridge is about 150 feet high, but the average height is about 60 feet.

The rocks are of Devonian age and are essentially a compact, finely granular limestone except at the south end where the bluff consists of chert. This chert makes up only a small portion of the ridge and the remaining portion which consists of limestone should prove entirely satisfactory for use as road material.

The Thebes branch of the Illinois Central Railroad runs close to the east side of the ridge, and could furnish transportation.

SOURCES OF LIMESTONE OF LOCAL IMPORTANCE

L No. 80

Limestones of Upper Mississippian age are exposed at many points near the base of the river bluff, from Sand Ridge to the Randolph County line. At most places, however, they are immediately overlain by sandstone and so covered by talus that the expense of development would scarcely justify the location of a quarry. However, in the NW. cor. sec. 34, T. 8 S., R. 4 W., (L No. 80) a bench of limestone 65 feet wide and 30 feet high, and with less than 10 feet of overburden, extends for more than 1,000 feet along the bluff and would furnish a large amount of stone.

Other outcrops of limestone are reported along Kinkaid Creek in T. 8 S., R. 5 W.; in the NW. ¼ sec. 5 and sec. 6, T. 8 S., R. 4 W.; and also at the south end of Fountain Bluff near Grand Tower. While some stone for local use might be obtained at these places, the site at Walker's Hill is so much more favorable that probably it would be advisable to obtain the rock there and haul it rather than develop new quarries.

JOHNSON COUNTY

Owing to the badly broken character of the country (fig. 58), rock outcrops are numerous in Johnson County. Roughly, the north third of the county is underlain by the sandstones and shales of Pennsylvanian age. The remaining two-thirds is underlain by the sandstones, limestones and shales of Upper Mississippian age except for a narrow strip in the southwest corner, where Lower Mississippian limestone is found. Because of its more resistant nature, sandstone caps practically all hills and ridges, and limestone outcrops are found mainly as narrow belts along the slopes.

Limestone can be obtained at numerous places in the county, but many of these localities are not within access of a railroad, and in many cases those which are near a railroad have so much shale present with the limestone that quarrying on a large scale would probably not be profitable

SHIPPING QUARRY

There is only one shipping quarry located in the county.

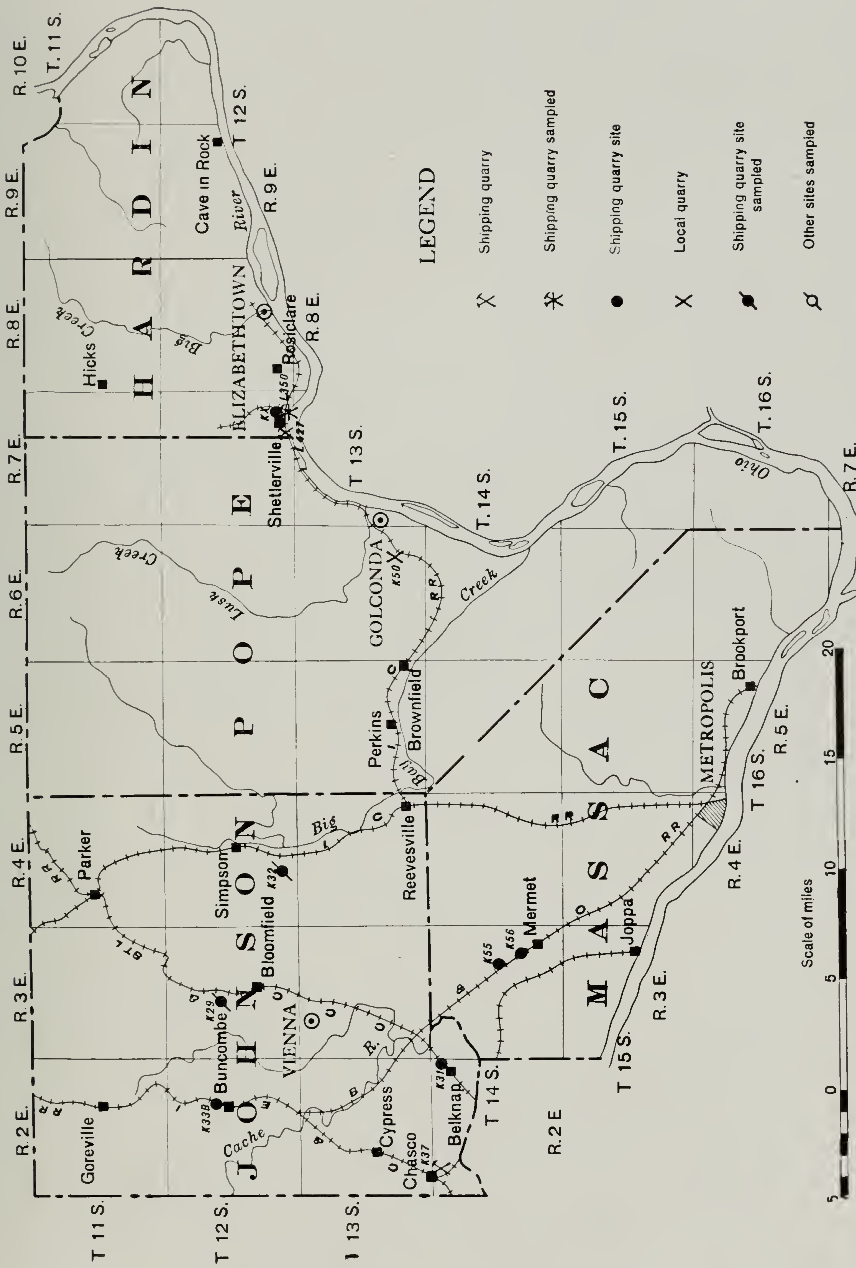

FIG. 58. Map of Johnson, Pope, Hardin and Massac counties showing location of quarries and quarry sites.

K No. 37

Charles Stone Company

SW. ¼ sec. 5, T. 14 S., R. 2 E.

The quarry at Chasco which is served by the Chicago and Eastern Illinois Railroad is located at the end of the hill forming a part of the north bluff of Cache River. The quarry face is semi-circular in outline, has a diameter of about 500 feet, and an average height of about 110 feet. The overburden is a yellow, residual clay and loess, and reaches a thickness of 18 feet in places, but averages about 10 feet. It is removed by teams and scrapers and by a steam shovel.

The rock being quarried is the Fredonia limestone and is essentially a compact, fine-grained, gray, or blue-gray stone. Oolitic layers occur locally in the upper portion of the face, especially, and also, though somewhat less commonly, near the bottom of the quarry.

Quarry practice is to drill twelve 5⅞-inch holes, 25 feet back from the face, and 15 feet apart. These holes are then loaded with 40 and 60 per cent dynamite and fired simultaneously. As much as 28,000 tons of rock have been broken at one blast.

The broken rock is hand-loaded into 5-ton cars and pulled to the tipple where the cable which is attached hauls them to the crusher. Masses too large to handle are broken by dobying or block-holing.

The crushing machinery includes a No. 7½ and a No. 5 Allis-Chalmers gyratory crusher and a No. 4 Williams pulverizer. The crushed rock is run through cylindrical screens and separated into the following sizes:

Size *Inches*	Approximate quantity *Per cent*
Dust	12½
¼–½	12½
½–1	16⅔
1–1½	16⅔
1½–2	16⅔
2–2½	25

Six bins each of 100-ton capacity are used as storage room. The capacity of the plant is 1,000 tons per day, but average production is about 500 tons.

Almost all the crushed rock produced at this quarry is sold within a radius of 70 miles and is used for railroad ballast, road material, aggregate in concrete, and for agricultural limestone. Chemical analyses show that most of the rock contains over 94 per cent calcium carbonate. The rock is also well suited for use as road material.

POSSIBLE SHIPPING QUARRY SITES

The lower Mississippian limestone which makes up most of the hills along the edge of the Cache bottoms from about a mile west of Belknap to the Union County line is the most suitable limestone in the county for large scale quarrying, because of its thickness, fairly uniform character, and freedom from shale. Outcrops of this limestone suitable for shipping quarries, however, are available near a railroad only in the SW. ¼ sec. 5 and the NW. ¼ sec. 6, T. 14 S., R. 2 E. Such limestones outcropping elsewhere within the county belong to the Chester group (Upper Mississippian), and though some of the Chester formations reach a thickness of 100 feet or more they contain large amounts of interbedded shale. The handling of this shale in providing clean limestone is a serious handicap to successful quarrying. In most outcrops, the shale intervals are not exposed so that it is advisable before any extensive quarrying operations are undertaken to explore the proposed site thoroughly either by trenching or drilling. In places limestone beds up to 20 feet in thickness and free from shale are exposed and may supply a local or temporary demand for crushed stone.

Though the Chester limestones are perhaps best suited to meet local demands, some of the most favorably situated with regard to railroad transportation are described under the heading of possible shipping quarry sites.

Area of Lower Mississippian limestone.—Of the two outcrops mentioned as being near a railroad the one in sec. 5, T. 14 S., R. 2 E. is already the site of the shipping quarry operated by the Charles Stone Company, and the other, which lies in the NW. ¼ sec. 6, T. 14 S., R. 2 E. is near the same railroad, the Chicago and Eastern Illinois.

The outcrop located in sec. 6, is about a quarter of a mile from the railroad and presents a steep slope, the lower portion of which is covered by loess washed down from above. The top of the limestone is about 100 feet above the flat, and the bluff-like face is about a quarter of a mile long. The limestone is capped by a thin sandstone bed which is in turn overlain by loess.

Near the edge of the bluff there is practically no overburden, but back from the bluff it increases and may reach a thickness of 20 feet and more. There is a strip about 300 feet wide over which the overburden averages less than 15 feet.

The rock is similar in character to that quarried at the Charles Stone Company, and probably would be satisfactory for road material, aggregate, ballast, and agricultural limestone.

As a thickness of 80 feet of rock occurs above the drainage level and the limestone is known to continue in depth for hundreds of feet more, the amount of rock available at this locality is sufficient to support a large quarry.

Chester limestone localities.—Places where the Chester limestones may be found in close proximity to the railroad are at Belknap, near Buncombe, about a mile and a quarter north of Bloomfield, in the hill in the SW. cor. sec. 10, T. 13 S., R. 2 E., and in the west central part of sec. 24, T. 13 S., R. 2 E.

K No. 31

Belknap area

Just north of the town of Belknap in sec. 1, T. 14 S., R. 2 E. bordering the Cleveland, Cincinnati, Chicago and St. Louis Railroad, is a bluff of limestone about three-fourths of a mile long. This bluff which is 150 feet high near Belknap slopes gently to the north until it is cut off by the valley of a small tributary of Cache River, which in working back into the bluff forms a broad ridge or nose at this point. Near Belknap the bluff is capped by a massive sandstone which extends within 50 feet of the edge. As the nose is approached, however, the sandstone cap turns more to the west, exposing 225 feet of limestone between it and the edge. Where the slope becomes more gentle at the end of the nose, even a greater width of limestone is available.

The thickness of overburden ranges from practically nothing at the edge of the bluff and on the north slope, to 40 feet where the sandstone is encountered. Though the gentle slope between the edge of the bluff and the sandstone appears to consist of soil, loess, sandstone, limestone and talus, it is very probable that considerable shale with some beds of limestone may be found. Should this be true, it is very doubtful whether it will be profitable to remove the entire overburden. The amount of rock available in the bluff is, therefore, limited to a narrow belt not more than about 100 feet wide. Probably the largest area free from the sandstone cap will be found near the north end of the bluff.

The character of the limestone exposed in the bluff indicates that the stone is suitable for road material. The interbedded shale and thin shaly limestones, however, are undesirable for this purpose and would have to be sorted out. As the limestone exposed in the quarry is identical with that overlying the rock found at the Whitehill quarry, it is very probable that upon deepening, a bed of calcareous sandstone will be encountered before the ledge of rock similar to that quarried at Whitehill is reached.

The rock most readily available is a strip less than 200 feet wide along the bluff and an area of several acres along the slope at the north end of the hill where the overlying sandstone has been removed by erosion. The height of the rock on this slope does not exceed 45 feet, but additional rock may be obtained by quarrying downward. The amount of rock that can be quarried at this locality is limited.

This locality is suggested as a quarry site mainly because of its location on the Big Four Railroad. A moderate amount of rock can undoubtedly be obtained here, and it might prove an economical source of rock for regions that can not be reached from quarries more favorably situated, without excessive freight haul.

K No. 33 B

At Buncombe

NE. ¼ sec. 15, T. 12 S., R. 2 E.

At the end of the ridge northeast of Buncombe a flat area of about 10 acres is underlain by the Kinkaid limestone. Higher up the ridge to the north this limestone is overlain by sandstone. The slope leading to the flat is gentle and is concealed beneath a covering of loess. No rock outcrops are found along the slopes, but from other exposures along the railroad in this vicinity the loess is estimated to be about 15 feet thick. The Chicago and Eastern Illinois Railroad runs along the east slope, about 40 feet below the flat.

The rock in the outcrop is a fine-grained, compact, blue-gray rock in beds of 4 to 6 inches, which breaks with subconchoidal fracture. Lenses and nodules of chert are common and some shale is found interbedded with the rock. The thickness of the rock is probably from 60 to 80 feet.

The advantage of this locality is its position along the railroad and that rock can be obtained in large quantities if necessary. The disadvantages of this location are the high initial cost of the land and expense of development. Another is competition from the quarry at Whitehill, which is on the same railroad and has a more favorable location.

K No. 29

Sec. 16, T. 12 S., R. 3 E.

A fine-grained, compact, blue-gray limestone, Kinkaid in age, outcrops along the creek bottom in the south-central part of sec. 16, T. 12 S., R. 3 E. about one and a half miles north of Bloomfield. Considerable chert as seams and nodules is present but not in quantity sufficient to affect the general character of the rock. The gentle slope of the outcrop suggests the presence of partings of shale, although none were actually observed. The slopes adjourning the creek are very gentle but appear to be unfit for cultivation. They are covered with a maximum of 8 feet of loess. The rock probably continues in depth for 80 or 100 feet. As the rock underlies nearly a whole section in this region and has less than 8 feet of overburden a large pit quarry might be located here.

The greatest disadvantage would be the expense of securing transportation facilities. Though the Big Four Railroad runs within half a mile of the locality, it is separated from it by a 60-foot ridge of sandstone except where the creek joins Little Cache Creek. At this point, however, the railroad grade is about 30 feet above the water level. As the railroad grade is blasted through a 30-foot ledge of sandstone at this place, it would be necessary to do a great deal of additional blasting to provide room for a spur and to build the track around the end of the ridge.

Millions of tons of rock are available and if a constant demand for rock were maintained, a large quarry might be located here. Before any development work is done, however, it would be advisable to ascertain the character and thickness of the rock to be quarried by core drilling.

K No. 32

SW. ¼ sec. 33, T. 12 S., R. 4 E.

At this location there is a hill about 80 feet high and 1,500 feet long and 1,000 feet wide, which is made up entirely of Menard limestone. The slope to the east is bare and relatively steep, but the slope to the west is gentle with a rise of about 11 feet in 100, and is covered with 6 to 10 feet of soil and loess.

The rock is a compact, fine-grained, blue-gray limestone. The presence of shale is suggested by the gentle slopes which are found at one or two places. The top of the hill is fairly flat, about 100 feet wide and 300 feet long. The amount of rock available for quarrying is probably not much over 100,000 yards.

The Illinois Central passes about one mile from the hill and the intervening surface is occupied by lowlands and swamps so that it is probable some filling and grading would be necessary in building a spur.

LIMESTONE OUTCROPS FOR LOCAL USE

In addition to the localities already mentioned, limestone outcrops from which rock for local use may be obtained are found at other places in the county.

Limestone outcrops at many places along the slopes of the ridge which extends from Simpson to Buncombe. The slopes of the hill in the south-central part of sec. 16, T. 13 S., R. 4 E. are composed of limestone, as are those at the cen. of sec. 3, T. 13 S., R. 3 E., those of the hill in SE. ¼ sec. 34, T. 12 S., R. 4 E., and along the bottom of the slope in the north-central part of sec. 9, T. 12 S., R. 2 E.

Limestone also outcrops on the slopes of the hills in the SW. cor. sec. 10, T. 13 S., R. 2 E., and in sec. 24, T. 13 S., R. 2 E. Both of these localities are within half a mile of the Chicago, Burlington, and Quincy Railroad and could furnish small amounts of rock for shipment.

The limestone belongs to the Golconda formation and is coarsely granular in texture but is well cemented, and is a hard limestone. Although no shale was observed at the outcrops, its presence is strongly suggested by the terraced slopes and by the occurrence of outcrops of this formation elsewhere in the region.

Both localities are separated from the railroad by Cache Creek and supplying railroad transportation would therefore be an expensive proposition and probably not warranted by the amount and character of rock available.

MASSAC COUNTY

Most of Massac County (fig. 58, p. 267) is underlain by unconsolidated sands and clays of Cretaceous-Tertiary age, and it is only in the northwestern part of the county that Paleozoic rocks outcrop.

POSSIBLE SHIPPING QUARRY SITES

Only two localities were observed in Massac County where limestone may be obtained in close proximity to a railroad. Both of these localities are near the Chicago, Burlington, and Quincy Railroad, one on the west side about a mile north of Mermet and the other on the east side of the tracks about two miles north of Mermet.

K No. 55

Isolated hill about two miles northwest of Mermet

The hill is somewhat oblong in shape, covers about 12 acres, at its highest point is about 60 feet above the flat, and slopes very gently to the flat in all directions.

A thickness of 28 feet of massive, blue-gray, compact Ste. Genevieve limestone is exposed. It is of the same age as that exposed in the quarry at Whitehill and may be expected to give similar results in tests. The overburden which attains a thickness of 11 feet consists of yellow, sandy soil and residual clay containing chert fragments.

The Chicago, Burlington and Quincy Railroad passes about one-fourth of a mile west of the outcrop.

K No. 56

Ridge about one mile northwest of Mermet

At this locality the Chicago, Burlington and Quincy Railroad cuts through the end of a northeast-southwest ridge. The ridge is about 50 feet high and less than 200 feet wide at the crest, and the length to its junction with a larger east-west ridge is about one-eighth of a mile. The slopes are gentle and are under cultivation.

A thickness of 26 feet of compact, massive, blue-gray Ste. Genevieve limestone similar to that exposed at the previously mentioned locality, is exposed at the end toward the railroad. The rock probably rises in the hill but the upper part is concealed by a yellow, sandy soil and a residual clay containing pebbles of chert. The thickness of the overburden is probably less than 10 feet.

DEPOSITS OF ONLY LOCAL IMPORTANCE

In addition to the localities already mentioned, limestone is known to outcrop at the north end of the ridge near the center of sec. 8, T. 14 S., R. 3 E. The limestone at this locality is a compact, fine-grained limestone of Ste. Genevieve age. Chert is common in some layers.

POPE COUNTY

Examination of Pope County (fig. 58, p. 267) reveals no limestone deposits suitable as a source of highway material located near a railroad. It is probable, however, that rock for local use may be obtained from the limestones of the Chester series which comprise the bed rock over much of the southern and eastern parts of the county.

No detailed survey was made to locate such outcrops but a few were noted.

K No. 50

S. ½ sec. 26, T. 13 S., R. 6 E.

An attempt was made to quarry limestone about 1½ miles west of Golconda for use as road material but the rock was found interbedded with shale to such an extent that separate recovery of limestone was found impracticable.

The limestone is exposed along the slopes of a narrow east-west ridge and it is probable that by working the outcrop along the slope, sufficient rock only for local use may be obtained. A crushing and screening apparatus has been installed.

Cen. sec. 27, T. 13 S., R. 5 E.

Thin slabs of Menard limestone are seen outcropping several places in the gentle slope along the Illinois Central Railroad at Perkins. The greatest thickness of limestone observed was 8 inches. A 4-foot section exposed in an excavation for a house foundation showed 4 feet of gray, siliceous shale containing several thin limestone layers. 2 inches or less in thickness.

NW. ¼ sec. 10, T. 14 S., R. 5 E.

The isolated ridge 3 miles south of Perkins trending in an east-west direction is about half a mile long, eighth of a mile wide and 80 to 100 feet high. Most of the north steep slope is covered, but at intervals a compact, blue-gray, siliceous limestone is exposed. The greatest exposure is 4 feet. The ridge probably consists of interbedded shale and limestone of the Menard formation. This site might serve as a source of rock for local use, as the overburden averages less than 3 feet in thickness.

Other localities

Limestone of Chester age also outcrops toward the head of Barren Creek near the Massac County line in sec. 16, T. 15 S., R. 6 E. The lower slopes of many hills in the southern portion of the county are known to show outcrops of limestone and can be used as a source of a local supply of stone.

PULASKI COUNTY

Limestone exposures in Pulaski County (fig. 60) are limited to the northern part where the bluffs along the Cache River are composed of this rock. South of the Cache River the limestone is too deeply buried by the sands and clays of Cretaceous-Tertiary age to be quarriable.

POSSIBLE SHIPPING QUARRY SITE

The only exposure of limestone in the county near enough to the railroad to warrant its consideration as a source for road material is along the bluff in the vicinity of Ullin where the rock was formerly quarried for ballast by the Illinois Central Railroad.

FIG. 59. Abandoned quarry near Ullin showing the Warsaw-Spergen limestone.

K No. 61

Abandoned quarry in sec. 14, T. 14 S., R. 1 W.

The old quarry (fig. 59) near Ullin is located in the side of a narrow ridge and is about 1200 feet long. The quarry face reaches a height of from 25 to 60 feet, and has been worked back more than 100 feet. At the west end of the quarry where the rock has been excavated below the level of the general quarry floor, there is now a pond more than 500 feet long, almost 100 feet wide and reported to be more than 50 feet deep.

East of the quarry the bluff gradually disappears. Westward, however it continues almost uninterruptedly to the road about one-quarter of a mile west, and remains prominent west of the road, but becomes progressively more distant from the railroad in this direction.

The rock exposed in the railroad quarry is a massive, gray, granular limestone containing scattered nodules and layers of chert. Farther to the west the rock is fine-grained, more cherty, and of a blue-gray color.

The overburden consists mainly of loess and residual soil, and though it reaches a thickness of 15 feet in places, it does not average over 8 feet. Any of the ravines cutting the bluff would serve as excellent dumping grounds.

Although large quantities of rock have been quarried here, a large amount still remains so that should rock be desired from this locality it might easily be obtained. The Illinois Central Railroad, about half a mile south of the outcrop, could provide transportation.

ROCK FOR LOCAL USE

Rock outcrops which might prove sources of road material for local use occur at many places north and south of Cache River along the bluffs and hills in the vicinity of Ullin.

North of Cache River the massive, light-gray, granular limestone of Warsaw-Spergen age outcrops along the ravines and slopes north of Mill Creek. This limestone is probably too soft for use as road material, but is one of the best limestones in the State for agricultural limestone.

Good exposures of the finer grained, compact limestones of St. Louis and Ste. Genevieve age are found in the hills along the north edge of the Cache bottom between Wetaug and the Johnson County line.

South of Cache River there are only a few scattered outcrops which might furnish rock for local purposes. These outcrops are along the slope in the SW. ¼ sec. 25, T. 14 S., R. 1 W., along the slope in the north-central part of sec. 19, T. 14 S., R. 1 E., and also along "Limestone" slough near the north line of sec. 22, T. 14 S., R. 1 W.

SALINE COUNTY

Limestone in sufficient quantity to be considered a source of road material is found only in the much faulted southeastern portion of Saline County where the limestone forms the lower slopes of the high ridge known as Cave Hill. The belt of outcrop extends from sec. 9, T. 10 S., R. 7 E., northeastward to the west line of sec. 34, T. 9 S., R. 7 E., where it ends at the broad ravine. Near the cen. sec. 35, T. 9 S., R. 7 E., limestone reappears along the lower slopes and outcrops more or less continuously to the Gallatin County line.

Most of the limestone is of Chester age, and is interbedded with sandstone and shale. It is capped by massive Pennsylvanian sandstone which makes up higher portions of the ridge. Talus from this sandstone covers most of the lower slopes of the hills.

These limestone formations are from four to six miles from the Cleveland, Cincinnati, Chicago and St. Louis Railroad and are separated from it by Saline River.

The difficulty of providing transportation, the faulted character of the rocks, the talus-covered slopes, and the fact that much of the limestone is interbedded with shale and sandstone, preclude any extensive quarrying operations. In a few areas, however, limited amounts of limestone can be obtained for local use.

Probably the best locality for obtaining rock for local use is the isolated hill in the north central part of sec. 36, T. 9 S., R. 7 E. The southern half of this hill, which is about a quarter of a mile long and 30 feet high, is composed of dark, fine-grained, siliceous limestone of the Osage group. It is much disturbed and fractured, and as a result breaks readily into small angular fragments. The overburden is light, ranging from practically nothing on the slopes to less than 10 feet at the crest of the hill.

Examination of the many small ravines cutting the slopes will reveal other places where limited amounts of rock can be obtained under varying conditions.

UNION COUNTY

There are many outcrops of limestone in Union County (fig. 60) which could furnish rock for highway construction, but only a few are near a railroad.

Limestones of the Chester group outcrop in many of the stream valleys in the northeastern half of the county; Lower Mississippian rocks make up the bed rock in the south-central part, and Devonian limestones underlie the western part of the county. Only one quarry producing crushed limestone is in operation.

SHIPPING QUARRIES

K No. 28

SE. ¼ sec. 17, T. 12 S., R. 1 W.

Anna Stone Company

The quarry of the Anna Stone Company is located in gently rolling country and is worked as a pit, which is circular in outline, about 500 feet in diameter, and has a face about 75 feet high. The overburden is of red residual clay and loess, ranging in thickness from about 5 to 15 feet, and

FIG 60. Map of Union, Alexander and Pulaski counties, showing location of quarries and quarry sites.

has an average thickness of about 12 feet. A section of the rock which is of Ste. Genevieve age is as follows:

		Thickness *Feet*
5.	Limestone, white, oolitic	15-18
4.	Limestone, compact blue, containing layers and nodules of chert	7
3.	Limestone, compact, fine-grained, blue-gray, containing a few widely scattered chert nodules	30
2.	Cherty limestone	7
1.	Limestone similar to No. 3	15

The rock is massive and in layers of varying thickness. The upper 15 feet is composed of beds varying from 3 inches to more than 1 foot thick, but in the lower 50 to 60 feet the bedding is not everywhere distinct. Beds 6 inches to 2½ feet thick were observed. The upper surface of the rock is very uneven and in places, especially along fractures where surface waters have dissolved much of the limestone, large pockets of red clay are found.

In quarrying, the full height of the face is worked. An electric well drill is used for making the blast holes, which are spaced about 15 feet apart and 15 feet from the edge. Fifteen holes are sprung simultaneously with sixty per cent dynamite.

The broken rock is loaded by hand and by steam shovel into quarry cars which are pulled to the tipple by a gasoline locomotive. There a cable is attached and the cars are pulled to the crushers and dumped.

The crushing machinery consists of one No. 12 and two 7½ Allis-Chalmers, and one No. 5 Austin gyratory crushers and an Allis-Chalmers hammer mill. The crushed rock is sorted by 3 cylindrical and 2 shaker screens into the desired sizes.

The daily production is about 2,000 tons. Concrete bins of the same capacity provide storage. The product is used for railroad ballast, aggregate in concrete, road material, and agricultural limestone.

Railroad transportation is provided by the Central Illinois Public Service Company, which has switching connections with the Illinois Central Railroad.

POSSIBLE SHIPPING QUARRY SITES

Despite the abundance of limestone, there are very few localities in the county where conditions are favorable for the development of shipping quarries.

The bed rock along the Illinois Central Railroad from Anna to the south line of the county consists of Lower Mississippian limestone, but the limestone is everywhere so deeply buried by loess and sand and gravel that it is unavailable.

The Missouri Pacific Railroad is near the Mississippi River bluff in the northwest part of the county, but the rock exposed in the bluff is not especially well adapted for use as road material in concrete roads. The steep face of the bluff 100 feet or more in height is composed of Devonian limestone known as the Bailey limestone. It is a thin-bedded, siliceous and shaly limestone overlain by Clear Creek chert, a flinty rock similar to that quarried at Tamms, but lacking the clay which makes that material self-binding.

Along the Mobile and Ohio Railroad, limestone outcrops are not prominent south of Jonesboro, but north of Jonesboro in the vicinity of Kaolin, several outcrops are located near the railroad. Of these outcrops the one at Tunnel Cut appears to be the most favorable for quarry purposes.

K No. 71

Tunnel Cut, sec. 2, T. 12 S., R. 2 W.

South of Kaolin the Mobile and Ohio Railroad cuts through a narrow ridge exposing about 30 feet of massive, granular, and partly crystalline, light-gray limestone.

The width of the crest of the ridge varies greatly from 50 feet and even less to more than 200 feet. The slopes are gentle, the base being more than 1,000 feet wide.

The surface of the rock is very uneven and the rock itself is much fractured. The overburden, which reaches a thickness of more than 15 feet in places, consists mainly of loess, but locally the lower 4 to 6 feet is composed of gravel. The slopes are covered by loess and gravel, the thickness of which it is advisable to determine by exploratory drilling before quarrying is begun.

There are probably about 8 acres within 1,000 feet of the track having an average thickness of approximately 20 feet of overburden.

The rock is probably too soft for use as road material and probably would test about the same as the rock at Ullin. The rock will, however, make excellent agricultural limestone and might be used for other purposes requiring a pure limestone.

LOCAL DEPOSITS

Practically every creek in the county exposes some rock and it is doubtful whether any locality within the county is located three miles from a limestone outcrop.

In the northeastern part of the county the Chester limestones outcrop at many places along the slopes of the hills. These limestones are generally interbedded with shale, but by working along the outcrops a sufficient quantity of rock for most local purposes can be obtained.

In the southwestern portion of the county Lower Mississippian limestones comprise the bed rock and outcrop along most of the larger creeks. These Lower Mississippian limestones vary greatly in character and often contain large quantities of chert. The Warsaw-Spergen formation, however, which is a light-gray, coarsely granular limestone is one of the purest limestones in the State, being almost entirely free from chert. Because of its softness and great purity it is especially well adapted for agricultural purposes. This limestone outcrops along the tributaries north of Mill Creek near the town of Mill Creek, and extends northward to the vicinity of Kaolin. Good exposures occur at Tunnel Cut near Kaolin, in Kratzinger Hollow, T. 12 S., R. 2 W., in many of the ravines in sec. 31, T. 12 S., R. 1 W., and also in the ravines of secs. 6, 7, 18, and 20 of T. 13 S., R. 1 W.

CHAPTER X.—LIMESTONE RESOURCES OF ILLINOIS—CENTRAL DISTRICT

By J. E. Lamar

The central district comprises about two-thirds of the total area of the State (fig. 1) and consists of those counties not included in the western, northern or southern districts. Most of this region is deeply covered by glacial drift and such outcrops as do occur are chiefly Pennsylvanian sandstone and shale. Locally, however, thin limestone beds are found.

As only a few of the limestones reach a thickness much over 6 feet, no great quantity of stone is available. However, as most of the large deposits of limestone from which crushed rock may be obtained are considerable distances away, such deposits as do exist in these counties may very well be a profitable source of stone for agricultural purposes, aggregate, bridge abutments, culverts, road repair, and occasional short stretches of new road.

In the survey of the central district no attempt was made to examine every county and only such counties were visited as were believed to contain limestone deposits of possible commercial value. The descriptions of the counties which were not visited have been taken from "The Geology of Illinois" by A. H. Worthen and others, and from other publications of the Illinois State Geological Survey bearing on the region under discussion.

BOND COUNTY

Along Dry Fork in the SE. ¼ SE. ¼ sec. 7 T. 6 N., R. 2 W., limestone with practically no overburden is exposed in an area 400 feet long and 200 feet wide. The rock attains a thickness of 8 feet and is a fine-grained, compact, gray limestone. Possibly 5,000 tons are available here.

Eight feet of compact, gray limestone outcrops along the creek near the center of the SE. ¼ sec. 30 T. 6 N., R. 4 W. The rock is thin-bedded and badly fractured, so that it resembles a brick wall. The outcrop extends along the creek for 200 feet, but as the overburden reaches a thickness of 15 feet within 50 feet of the bank, only the rock in a strip several feet wide is available for quarrying. The quantity of stone that can be obtained profitably here is probably less than 1,000 tons.

A similar outcrop occurs about three-quarters of a mile upstream.

Five feet of massive, dense, gray limestone is exposed along the bank of Locust Creek in the NE. ¼ NE. ¼ sec. 28, T. 4 N., R. 4 W., but the heavy overburden, 25 feet in places, makes it doubtful that the stone can be quarried profitably back for more than a few feet. The quantity of rock available is less than 1,000 tons.

BROWN COUNTY

The following outcrops of limestone are reported in Brown County:

Pennsylvanian limestone.—In the vicinity of Mt. Sterling a bed of limestone 4 to 6 feet thick is exposed. Elsewhere in the county 3 to 6 feet of limestone is found locally a few feet below the coal commonly mined.

Mississippian limestone.—The St. Louis formation in Brown County consists of an upper bed of hard, concretionary, gray limestone from 5 to 10 feet thick and a lower member of brown, magnesian limestone locally very sandy or shaly. The upper gray limestone is well exposed on Dry Fork of McGees Creek about 6 miles south of Mt. Sterling, at LaGrange, and in the bluffs of Crooked Creek near Ripley. The lower, brown, magnesian limestone is well exposed in the bluffs of McGees Creek about 7½ miles southwest of Versailles, in the Illinois River bluff about 2 miles southeast of Versailles, at LaGrange, and in the bluffs of Crooked Creek in the vicinity of Ripley.

The most extensive outcrops of the St. Louis formation in this county occur in the bluffs along Illinois River, Crooked Creek, and McGees Creek, and along some of their principal tributaries.

The Keokuk formation as exposed consists of shale containing numerous geodes, underlain by a few feet of thin-bedded limestone. It outcrps along Crooked Creek for its entire length in the county and also on the lower course of McGees Creek.

BUREAU COUNTY

No limestone outcrops of importance have been reported.

CASS COUNTY

Cass County contains no outcrops of limestone of importance. However, two feet of Pennsylvanian limestone is reported to outcrop in a large ravine cutting through the bluffs in the southern portion of sec. 10, T. 18 N., R. 7 W., and also in another ravine nearly on the line between secs. 10 and 11 in the same township.

CHAMPAIGN COUNTY

No outcrops of limestone are known in this county.

CHRISTIAN COUNTY

Four feet of ash-gray limestone is reported as outcropping 6 miles northwest of Pana, on the south fork of Sangamon River in sec. 13, T. 15 N., R. 3 W. and in sec. 16, T. 14 N., R. 3 W. Eight miles northwest of Pana it was quarried for local use.

Fig. 61. Map of Clark County, showing location of quarries and quarry sites.

CLARK COUNTY

The bed rock of Clark County (fig. 61) is buried under a mantle of glacial drift 20 to 60 feet thick, and is exposed only along the stream courses. The outcrops consist of shales, sandstones, and thin limestones of Pennsylvanian age. Some of the limestone exposures are as much as 20 feet thick, but the average is probably less than 10 feet. The limestone is not limited to any one area but occurs at many widely separated localities. Many of these exposures are capable of yielding considerable quantities of rock.

Though the rock from many of these outcrops has, at one time or another, been quarried for local use, only one quarry in the county has shipping facilities—that of the Illinois Limestone Company.

SHIPPING QUARRY

L No. 38

Illinois Limestone Company

The quarry of the Illinois Limestone Company is located in the prairie about a mile south of West Union, in the central part of the E. ½ SE. ¼ sec. 19, T. 9 N., R. 11 W.

The rock is a fine-grained, compact, and hard, buff-colored limestone about 5 feet thick, underlain by blue clay shale. The beds of the limestone are less than 6 inches thick and are rather prominently jointed, so that rock breaks readily into small pieces. It is reported that another layer of limestone of about the same thickness lies 16 feet below the bed now being quarried.

The stone is taken from a pit somewhat irregular in outline, about 950 feet long and 140 feet wide. Inasmuch as the stone which is quarried is only 5 feet thick the pit is very shallow. The overburden, a sandy black loam, averaging one foot in thickness, is removed by wheeled scrapers and dumped into abandoned portions of the quarry.

In quarrying, the blast holes are drilled with jackhammers and the rock shot down with 60 per cent dynamite. The broken rock is loaded by steam shovel into two-ton cars drawn to the tipple by horses. Masses of rock too large to handle in this way are reduced to "man-size" by breaking with sledge hammers.

The crushing machinery consists of a No. 5 Allis-Chalmers gyratory, an 8-by 16-inch Blake jaw crusher, and a No. XXX Gruendler pulverizer. The crushed rock is separated by means of a 40-inch by 16-foot Austin cylindrical screen into four sizes:—dust, 5/16 to ¾ inch, ¾ to 1¾ inch, and over 1¾ inch.

The daily production is from 200 to 250 tons; the yearly production about 30,000 tons. Bins provide storage for 700 tons.

Transportation is furnished by the Cleveland, Cincinnati, Chicago and St. Louis Railroad.

Tests show the rock to be well adapted for both agricultural use and road material. Most of the product, however, is sold for agricultural purposes.

DEPOSITS OF LOCAL IMPORTANCE

L No. 39

The quarry of the Casey Stone Company is located along a creek in the north-central part of the SE. ¼ sec. 28, T. 10 N., R. 14 W. (fig. 61). It has a daily capacity of about 200 yards of crushed rock. It has no railroad facilities, and is operated only when there is a local demand for crushed rock. The quarry has a 16-foot face, which extends along the creek for about 1,100 feet, and is about 90 feet distant from it. As the quarry face has been worked back from the creek, the overburden, a sandy clay till,

Fig. 62. Pennsylvanian limestone as exposed at the quarry of the Casey Stone Company, near Casey.

has become thicker until it averages about 15 feet at the present position of the quarry face. It is reported that further quarrying may be stopped on account of the thickness of the overburden.

The rock exposed in the quarry face, fig. 62, is a compact, fine-grained, hard, somewhat brittle, gray limestone. Much of it is comparatively thick-bedded and relatively free from joints or fractures. The following section is exposed in the quarry:

	Thickness Ft.	In.
3. Heavy-bedded, gray limestone, weathers to slabs 1½ to 2 feet thick	3	9
2. Hard gray limestone in 3- to 6-inch beds, badly jointed............	2	6
1. Massive blue-gray limestone, breaks in 2-foot slabs on blasting.....	6	9

The quarry floor is of limestone, but the bottom of the bed is only a few feet below.

The quarry was not active at the time of investigation, but from existing sources of information the method of operation seems to be about as follows.

Blast holes are drilled with a steam drill to the bottom of the face and the entire face shot down at once. The broken rock is hand-loaded into two-ton cars and hauled to the tipple by horses. A cable is then attached, and the cars are drawn up to the crusher.

The crushing machinery consists of a Butterworth and Lowe jaw crusher. The crushed rock is run through a screen and separated into four sizes:—dust to 5/16-inch, 5/16- to ¾-inch, ¾ to 1¾-inch, and over 1¾-inch. In practice about 5 per cent of rock is less than 5/16-inch, about 10 per cent is 5/16 to ¾-inch, and 25 per cent from ¾ to 1¾-inch or larger.

In addition to the 1,100 feet of rock exposed on the quarry face, the limestone outcrops upstream at intervals for nearly 4,000 feet and downstream for about 2,000 feet. Owing to the dissected character of the surface, the overburden varies in thickness from place to place. It reaches a thickness of 25 feet in the hills, while in the ravines or low places it is not over 5 feet thick. For an area about 100 feet square the overburden would average about 15 feet. Back from the creek the rock has been encountered in many of the wells at depths which make it seem likely that limestone with an overburden of 15 feet or less underlies probably several sections.

If railroad transportation were available and if adequate machinery for the removal of overburden were secured, relatively large quantities of crushed rock could be obtained here on a commercial basis.

Most of the output of this quarry has been used on roads for which purpose it appears to be well suited. When the plant was in operation the production was reported to have been about 200 tons daily.

L No. 33

This outcrop is located along the creek in NW. ¼ NW. ¼ sec. 29, T. 11 N., R. 11 W. Rock has been quarried here both for agricultural limestone and for use on local roads.

The rock is a fine-grained, compact, fairly hard, gray to blue-gray limestone. The section is as follows:

	Thickness *Ft.*	*In.*
3. Thin-bedded limestone. weathers into 3- to 6-inch slabs............	6	2
2. Massive, blue-gray limestone, weathers into slabs 1 to 2 feet thick..	16	7
1. Shale with thin beds and nodules of limestone and locally 6 inches of coal	0	6

The upper thin-bedded limestone appears to be somewhat softer than the underlying more massive rock. The former is a very pure limestone containing as high as 97 per cent calcium carbonate; the latter is somewhat siliceous.

In quarrying, a face 22 feet high and 125 feet long is worked along both sides of the creek. The overburden is sandy clay till of variable thickness, averaging about 12 feet, with a maximum of 20 feet. For short stretches along the creek the overburden near the banks may be less than 10 feet. The topography near the creek is flat or gently rolling, shallow ravines alternating with low rounded hills and ridges.

As this locality has no railroad facilities, production on a large scale is out of the question, and for small production in which much of the work is done by hand, a thickness of 10 to 15 feet of overburden proves a serious handicap. However, by selective quarrying—that is, by quarrying the rock only in places where the overburden is thin—many thousand cubic yards of stone may be obtained from the 1500-foot outcrop along the creek.

The Cleveland, Cincinnati, Chicago and St. Louis Railroad is about 1¼ miles west of this outcrop. The intervening territory is flat or gently rolling. Several sections are probably underlain by limestone, and the potential quantity of rock obtainable from this area is large.

L No. 34

Limestone similar to that which is exposed at L No. 33 outcrops in and along the creek in the SW. ¼ NE. ¼ sec. 19, T. 11 N., R. 11 W. The distance to the Big Four Railroad is less than a mile.

In the past, rock has been quarried here for use as agricultural limestone and for use on local roads. The old, roughly circular quarry is 65 feet long and 55 feet wide, and has a 15-foot face. The average thickness of the overburden is 10 to 15 feet. Over an area of about 6 acres the stripping is less than 10 feet.

The quarry was not in operation when visited, but the blast holes apparently are made with a steam drill, and the rock hand-loaded. The stone is run through a small portable crusher with a reported capacity of about 150 cubic yards per day.

About 6 acres are underlain by this limestone with less than 10 feet of overburden and an immense quantity of stone is available with less than 15 feet of overburden. It is reported that some years ago a large company contemplated locating a quarry here, but was unable to procure the land lying between the railroad and the proposed quarry site.

L No. 35

The limestone which outcrops at L No. 33 and L No. 34 is also exposed along the creek near the center of the SE. ¼ sec. 20, T. 11 N., R. 11 W. The overburden and topography are generally similar to that of the other localities already mentioned. All three exposures—L No. 33, L No. 34 and L No. 35 outcrop east of Marshall, within an area of 3 square miles in T. 11 N., R. 11 W.

Sec. 12, T. 11 N., R. 12 W.

This outcrop occurs just east of the Cleveland, Cincinnati, Chicago and St. Louis Railroad along a tributary of Big Creek, in sec. 12, T. 11 N.,

R. 12 W. (fig. 63), and extends for about 500 feet east from the railroad. Approximately 14 feet of limestone is exposed but it is separated into two benches by a 4-foot shale bed. The section is as follows:

	Thickness Ft.	In.
4. Hard, gray-brown limestone	4	2
3. Gray, clay shale (iron-stained)	4	2
2. Massive, gray-brown limestone	5	7
1. Thin-bedded, shaly limestone	4	3

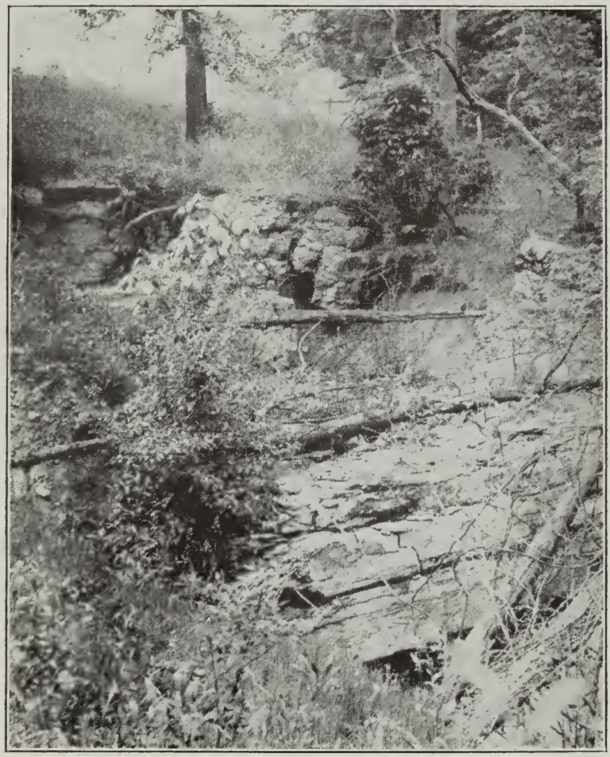

Fig. 63. Pennsylvanian limestone in sec. 12, T. 11 N., R. 12 W., Clark County.

The limestone in Nos. 2 and 4 of the above section is hard, massive, and gray brown. It is little jointed and weathers into slabs 8 to 18 inches thick.

The overburden is composed of clay till and varies in thickness from almost nothing near the outcrop to 30 feet a short distance back from the creek. Since it is impracticable to remove 15 feet of overburden to obtain 4 feet of stone and then to remove 4 feet of shale to procure the remaining 5 feet of rock, this locality will furnish economically only such rock as can be obtained by working along the outcrop.

Sec. 12, T. 11 N., R. 12 W.

This outcrop occurs along the upper slope of a stream valley in the SE. ¼ sec. 12, T. 11 N., R. 12 W. The exposure is about 1,600 feet in length and consists of a 6-foot bed of limestone underlain by alternating shales and thin limestones. The uppermost limestone bed is a hard and compact gray limestone which weathers into large blocks. It has been used to some extent as foundation stone and in repairing local roads. The overburden is clay till and reaches a maximum thickness of about 30 feet, but averages about 15 feet.

Although the rock undoubtedly underlies the uplands in this vicinity, the relative thickness of overburden will prohibit quarrying except on a small scale. Approximately 10 acres have an overburden less than 15 feet thick. By quarrying a narrow strip along the outcrop with a small overburden, about 5,000 yards of crushed rock might be obtained.

Sec. 6, T. 11 N., R. 11 W.

Fifteen feet of compact, gray limestone underlain by shale with thin bands of limestone is exposed along the west bank of Big Creek in the SE. ¼, NW. ¼, sec. 6, T. 11 N., R. 11 W. Parts of the upper 10 feet of the outcrop are concealed and may be shale. Like most creek outcrops, the overburden rises rapidly from the edge of the rock, thickening to 50 feet within several hundred feet of the bank. Where erosion has been active the overburden is thinner, but the average thickness is well over 25 feet.

Some rock has been quarried here to supply stone for the construction of the Big Four Railroad bridge over Big Creek.

The rock outcrops along the creek at intervals for several thousand feet, but only a strip less than 50 feet wide is available for quarrying, so that this deposit will be of interest only for meeting local demands.

Sec. 6, T. 11 N., R. 11 W.

The formation which is exposed at the preceding location also outcrops along the east bank of Big Creek in the NW. ¼ NW. ¼ sec. 6, T. 11 N., R. 11 W. The overburden rises rapidly away from the bank to a thickness of about 25 feet. Over any area more than 25 feet wide along the bank, the average overburden is about 25 feet thick. By quarrying a narrow belt along the creek, several thousand yards of rock might be obtained.

Sec. 27, T. 12 N., R. 13 W.

A 6-foot bed of compact, gray limestone outcrops along a small creek in NW. ¼, NW. ¼ sec. 27, T. 12 N., R. 13 W. The overburden rises rather rapidly away from the stream, so that at 200 feet from the bank it is 20 or more feet thick. For most of the length of the outcrop, however, there is a strip about 100 feet wide with less than 10 feet of overburden.

Though only 6 feet of rock is exposed it is very probable that the total thickness of the limestone is about 16 feet, and also that some shale beds will be found interbedded with the lower unexposed stone.

As there is no railroad within 6 miles of this locality, it is very probable that stone for use in local roads can be obtained here at less cost than would be the case if crushed rock were shipped in.

The rock outcrops for more than a quarter of a mile along the creek, and if a strip about 100 feet wide is underlain by limestone which averages 12 feet in thickness this tract would furnish about 60,000 cubic yards of stone.

Sec. 27, T. 12 N., R. 13 W.

About half a mile southeast of the preceding outcrop, limestone 7 feet in thickness outcrops along the stream in the SE. ¼ NW. ¼ sec. 27, T. 12 N., R. 13 W. The overburden is a yellow clay till, varying in thickness from nothing to 28 feet. It increases rapidly back from the outcrop so that any relatively large area has an average overburden of about 20 feet. The rock is a compact, gray limestone, very similar to that at the preceding location, but appears to be a lower bed. It may continue in depth for several feet more, but it is doubtful whether limestone much over 10 feet thick is available.

Limestone could be obtained with an average overburden of less than 5 feet on the 5-acre tract south of the house on the farm, and in a narrow strip 25 to 50 feet wide along the creek bank. Such a strip could be quarried for nearly half a mile along the creek.

Other similar outcrops occur at intervals along the stream as far as the Edgar County line. This region of which this area and that immediately preceding are typical examples, could furnish ample stone for use on the roads of the surrounding country.

Other localities

Besides the outcrops already mentioned, the following of less importance and less favorably situated may be noted.

SW. ¼ SW. ¼ sec. 19, T. 10 N., R. 11 W.—About 8 feet of limestone with an average of 28 feet of overburden outcrops along the creek.

NW. ¼ NW. ¼ sec. 12, T. 9 N., R. 12 W.—About 8 feet of limestone with 40 feet of overburden outcrops along the stream.

SW. ¼ SW. ¼ sec. 9, T. 10 N., R. 13 W.—Limestone 8 feet in thickness with an overburden of 15 feet outcrops along the stream.

SW. ¼ SW. ¼ SE. ¼ sec. 8, T. 11 N., R. 11 W.—Ten feet of limestone overlain by heavy overburden outcrops in the hillside along the National Road.

NW. ¼ NW. ¼ NW. ¼ sec. 7, T. 11 N., R. 11 W.—Six feet of limestone overlain by heavy overburden outcrops in the hillside along the Pittsburgh, Cincinnati, Chicago and St. Louis Railway.

CLAY COUNTY

Secs. 17 and 20, T. 4 N., R. 6 E.

Three feet of compact, hard, gray limestone outcrops along a tributary of Crooked Creek in secs. 17 and 20, T. 4 N., R. 6 E. Though most of the area is covered by overburden too thick to permit economical quarrying, there are a few localities with an overburden only 1 or 1½ feet thick, and it is very probable that these may furnish several thousand tons of rock.

Sec. 25, T. 5 N., R. 5 E.

Three feet of limestone is exposed at several places near the brows of the hills adjoining Dismal Creek in sec. 25, T. 5 N., R. 5 E., but at no one place is more than 1,000 tons of rock available.

Sec. 14, T. 4 N., R. 5 E.

The three-foot bed of limestone located in sec. 25, T. 5 N., R. 5 E., outcrops also along a tributary of Crooked Creek in the east-central part of sec. 14, T. 4 N., R. 5 E. There are a few small areas of several hundred square feet where the overburden is not too thick to prevent profitable quarrying.

CLINTON COUNTY

Sec. 3, T. 3 N., R. 4 W.

Five feet of compact, blue-gray limestone is exposed along the creek in the NW. ¼ NW. ¼ sec. 3, T. 3 N., R. 4 W., approximately 250 feet below the exposure of rock in the bed of the creek. It forms the banks, and 1,500 feet farther downstream it is found on the slopes, 50 to 100 feet back from the creek. The creek is shallow, and where limestone forms the bed, is less than a foot deep.

The area of available rock is limited to a strip 20 feet wide and 200 feet long in the bed of the creek, and to a narrow strip from 2 to 10 feet wide along the bank. Many other tributaries in this township have limestone along the banks or in their beds, so that the total amount of limestone that can be obtained in this township will probably be over 100,000 tons. Locations of other limestone outcrops are along the tributaries in SW. ¼ sec. 2, SW. ¼ sec. 11, NW. ¼ sec. 26, SE. ¼ sec. 27, and NW. ¼ sec. 35, T. 3 N., R. 4 W.

Sec. 24, T. 3 N., R. 4 W.

Probably the most favorable locality in Clinton County that can supply stone for local purposes is along Shoal Creek in the NE. ¼, SW. ¼ sec. 24, T. 3 N., R. 4 W., where 8 feet of hard, compact, blue-gray limestone forms a miniature bluff. At low water the bluff is about 20 feet above stream, but at high water it is almost covered. The cliff extends for a quarter of a mile along the creek. The overburden is a red clay till which thickens rapidly away from the bank, though for the first 10 feet the average overburden is only about 4 feet.

The amount available from the 10-foot strip is about 20,000 tons. Shoal Creek carries enough water so that hydraulic methods could be used in removing the overburden. If this were done it is very probable that more than twice as much rock could be procured. Since the outcrop is six miles from the nearest railroad it might prove a convenient source of rock for local roads.

A somewhat similar outcrop is found along the creek near the old mill in the NE. ¼ SW. ¼ sec. 12, T. 2 N., R. 4 W. Six feet of limestone form a small cliff 600 feet long, but the overburden is about 6 feet thick at the bank and thickens rapidly to 15 feet.

Limestone is exposed at several other places in the county, but the rock is so heavily covered with drift that only very limited quarrying is possible.

COLES COUNTY

Rock was formerly quarried at the SE. ¼ SW. ¼ sec. 5, T. 12 N., R. 10 E., where about 15 feet of Pennsylvanian strata are exposed in the bank of Embarrass River (fig. 64). The old quarry which is now dismantled, was 250 feet long and 60 feet wide. The overburden is yellow clay till and ranges in thickness from 3 to 30 feet with an average of about 10 feet. There are about 40 acres where the overburden does not exceed 8 feet.

The section at the quarry is as follows:

	Thickness	
	Ft.	*In.*
Compact limestone, weathers into 2 to 4-inch layers	9	..
Drab clay shale	1	3
Compact, blue-gray limestone in 6-inch ledges	1	2
Blue-gray limestone, splits into 4 to 6-inch layers	2	5
Massive, blue-gray limestone	1	10

In addition to the exposure in the quarry face, the rock can be traced south for about 550 feet along the east bank of the river, but the thickness of drift renders quarrying out of the question. To the north, the rock outcrops for about 2,000 feet forming the bluffs along the east bank of the river. In most places the overburden is heavy, but about 750 feet south of the old quarry there is an area about 800 by 300 feet, where the stripping would be less than 10 feet and much of it not over 6 feet.

Outcrops of this same limestone bed are found along the west bank of the river, but the exposures are fewer and the overburden is commonly more than 10 feet.

The Cleveland, Cincinnati, Chicago and St. Louis Railroad runs within half a mile of the outcrop at the quarry.

Fig. 64. Pennsylvanian limestone in abandoned quarry located in sec. 5 T. 12 N., R. 10 E., east of Charleston.

CRAWFORD COUNTY

It is reported that two feet of hard, gray limestone is exposed in the creek bed in the NW. ¼, sec. 7, T. 8 N., R. 13 W., and that 18 inches of hard, dark-gray, bituminous limestone outcrops in the bed of Turkey Creek about 4 miles southwest of Robinson.

CUMBERLAND COUNTY

NW. ¼ NW. ¼ sec. 12, T. 10 N., R. 9 E.

About 9 feet of limestone outcrops along the creek at the above location. The rock is a thin-bedded, buff limestone, rather hard and brittle, and weathers to thin slabs. Over most of the area the overburden is too thick to admit profitable working, but on the flood plain from 20 to 30 feet wide and about 300 feet long the overburden is less than 10 feet thick.

The quantity of stone available is probably less than 1,000 tons. A few other exposures of limestone occur in the county, but most of the limestone outcrops are only 3 feet thick and are everywhere buried under such a depth of overburden that profitable quarrying is impossible.

DEWITT COUNTY

No outcrops of limestone are known in this county.

DOUGLAS COUNTY

No limestone outcrops are reported from this county.

EDGAR COUNTY

The bed rock of Edgar County is of Pennsylvanian age, and is buried by 20 to 100 feet of glacial drift. Though most exposures reveal shales or sandstones, limestone in thicknesses up to 25 feet outcrop at several places in the county. These exposures are all typical stream outcrops, that is, the rock is exposed only in and along the creek bottoms, while on both sides the drift rises rapidly to heights of 20 to 30 feet above bed rock. As a result, only a narrow strip immediately adjoining the stream is available for quarrying. Fortunately, these streams are generally so shallow and small that they would not seriously handicap quarrying operations, except perhaps in the spring.

As many of these exposures are found at some distance from railroads, they may be of importance only as a source of crushed rock for roads in the immediate vicinity.

QUARRY SITES

There are no shipping quarries or good sites for shipping quarries in this county due to the lack of a sufficiently thick limestone and a thin overburden. The following are possible sites for local quarries.

SE. ¼ NE. ¼, sec. 10, T. 14 N., R. 11 W.

As at other valley outcrops, the slopes of glacial drift rise gradually on both sides of the stream to heights of 20 feet or more above bed rock. As a result there is only a narrow strip near the bank where the overburden is less than 10 feet. The width of this strip is somewhat variable. Where the surface run-off has formed youthful valleys the strip overlain by thin overburden is wider but it averages generally less than 75 feet in width.

The thickness of the limestone exposed here is about 12 feet. The different beds vary somewhat in character, but in general the rock is fine-grained, hard, and compact, and gray or blue-gray in color. The section follows:

	Thickness Ft.	In.
6. Massive, hard-gray limestone	3	9
5. Gray clay shale	1	3
4. Hard, compact limestone	2	6
3. Limestone, weathering to thin slabs	2	6
2. Blue-gray limestone, somewhat nodular and in 2- to 6-foot beds	3	8
1. Shale and sandstones	10+	..

The presence of the shale bed might prove objectionable if rock were to be used as aggregate for concrete. If, however, it were used for water-bound macadam, such shale as would adhere to the crushed and screened rock might serve as a binder.

Since the rock outcrops for a quarter of a mile along the creek, a total of more than 50,000 cubic yards of stone is obtainable with less than an average overburden of 5 feet. Limestone also outcrops at intervals along the creek for a distance of about 3 miles, so that a considerable tonnage of crushed rock is available in this region.

W. ½ SW. ¼ sec. 1, T. 12 N., R. 13 W.

About 14 feet of limestone outcrops along the creek. As at other stream valley outcrops, there is only a narrow strip along the bank where the rock has less than 10 feet of overburden.

It is a hard and compact, fine-grained, blue-gray limestone, which weathers to 3- or 6-inch layers. Only the upper 11 feet is fully exposed, the lower beds being partly concealed by talus. The obscured beds may be shale.

The section is as follows:

	Thickness Ft.	In.
6. Hard, blue-gray limestone, weathers in 3- to 6-inch layers	10	8
5. Concealed	3	6
4. Compact gray limestone	1	0
3. Covered by talus	7	5
2. Limestone partly covered	5	0
1. Compact gray limestone	2	2

Assuming that a strip 50 feet wide is available, the outcrop would yield more than 40,000 cubic yards of crushed rock.

Sec. 11, T. 12 N., R. 13 W.

This deposit is located along the creek in SE. ¼ SE. ¼ sec. 11, T. 12 N., R. 13 W. The overburden is a gravelly clay till, and has a maximum thickness of more than 20 feet, but where the rock outcrops along the creek for about a quarter of a mile, there are possibly 30 acres on which the overburden averages less than 10 feet.

The general character of the rock is identical with that of other localities in the county. The section exposed is as follows:

	Thickness Ft.	In.
5. Blue-gray limestone, weathers to thin 2- to 4-inch layers	7	3
4. Massive limestone, weathers 4- to 8-inch layers	4	8
3. Massive, gray limestone, breaks into angular blocks	2	7
2. Brown and gray clay shale	2	2
1. Hard gray limestone	11	0

Rock available for quarrying is limited to the narrow strip along the creek where the stripping is less than 10 feet. About 100,000 tons are available.

Sec. 3, T. 15 N., R. 12 W.

About 15 years ago a 12-foot ledge of limestone was quarried along the creek in the NE. ¼ NE. ¼ sec. 3, T. 15 N., R. 12 W. The rock was used on local roads and some of it was burned for lime.

The quarry has been abandoned and is now filled with water. It is about 260 feet long and 108 feet wide. The overburden of clay till ranges in thickness from 5 to 20 feet and averages about 12 feet. It is very probable that the increasing thickness of overburden was a factor in the abandonment of the quarry.

The stone appears similar to that found at other places in the county and seems well adapted for road material. The exposure is about 1,200 feet long, and there are probably 30 acres along the creek on which the average overburden is 12 feet.

The Cincinnati, Indianapolis & Western Railroad is about half a mile north of the outcrop, so that a spur might easily be built. It is doubtful, however, whether the amount of rock obtainable without prohibitive amount of stripping, would warrant the building of a spur. By working a narrow strip along the bank, however, enough stone to build several miles of road could easily be obtained.

Sec. 32, T. 14 N., R. 11 W.

Limestone similar to that already described outcrops along the creek in the center of the section.

Other localities

The exposures cited are not the only ones in the county, but are perhaps the most important. Similar outcrops may be found along some of the other creeks.

EDWARDS COUNTY

No limestone outcrops are reported from this county.

EFFINGHAM COUNTY

Small quantities of rock might be obtained along the creek bottom in the SW. ¼ sec. 12, T. 6 N., R. 4 E., where there are limited areas underlain by 3 feet of limestone with less than 5 feet of overburden. The rock is a compact, massive, hard limestone.

Similar exposures are found along Big Creek in the NE. ¼ NE. ¼ sec. 26, T. 7 N., R. 5 E., where outcrops of 3 feet of compact, hard, gray limestone might yield several hundred tons of rock.

FAYETTE COUNTY

Two outcrops of limestone are reported from this county, one, 3 feet thick located near the intersection of Ramseys Creek and the railroad, and another 6 feet thick located on Becks Creek in sec. 10, T. 8 N., R. 2 E.

FORD COUNTY

No outcrops of limestone are known in this county.

FRANKLIN COUNTY

Limestone is reported to outcrop in sec. 11, T. 5 S., R. 4 E.

FULTON COUNTY

Both Pennsylvanian and Mississippian limestone strata are reported to outcrop in Fulton County.

Pennsylvanian limestone.—In the vicinity of Cuba and Canton from 3 to 6 feet of hard, blue limestone overlie the coal. Also two limestone beds[2] 4 and 5 feet thick respectively and separated by 7 feet of calcareous shale have been quarried about 2½ miles east of Farmington. The stone is hard and gray in color, and is probably present over a few square miles south of Farmington.

Mississippian limestone.—The gray, concretionary beds of the St. Louis limestone outcrop at intervals in the bed of Spoon River from Seville to Bernadotte.

HAMILTON COUNTY

No limestone outcrops are known in this county.

HENRY COUNTY

The following outcrops of limestone are reported in Henry County.

Pennsylvanian limestone.—One to two feet of hard, blue, shelly limestone is exposed above the coal in stripping operations in the vicinity of Cleveland.

[2]Savage, T. E., Geology and mineral resources of the Avon and Canton quadrangles: Illinois State Geological Survey Bull. 38, p. 59, 1921.

Devonian limestone.—The Hamilton limestone is exposed in the bed of Rock River and locally in the bluffs along the bank, from a point about 1½ miles northeast of Cleveland southwest to the west county line. The Hamilton is a solid, massive, bluish-white limestone and commonly breaks with a smooth conchoidal fracture.

Silurian limestone.—The Niagaran dolomite outcrops in the bed and to a limited extent in the banks of Rock River from the north county line southwest about half way to Cleveland. The rock is a soft, fine-grained, yellowish dolomite.

IROQUOIS COUNTY

No limestones are known to outcrop in this county.

JASPER COUNTY

A limestone 12 to 18 inches thick is reported to outcrop along Limestone Creek in the southwestern portion of the county.

JEFFERSON COUNTY

Argillaceous limestone up to 5 feet thick is reported from sec. 25, T. 1 S., R. 2 E.

KNOX COUNTY

A bed of Pennsylvanian limestone which overlies a coal seam and varies from one to four feet in thickness is reported to outcrop locally in this county. The best exposures occur in sec. 25, T. 9 N., R. 4 E., south of Yates City, and along Spoon River in sec. 12, T. 10 N., R. 3 E., where the beds of limestone are 3 and 4 feet thick respectively. Near the center of sec. 24, T. 12 N., R. 2. E., limestone has been quarried for making lime.

LAWRENCE COUNTY

No limestone outcrops more than 2 feet thick are reported from this county.

LIVINGSTON COUNTY

Limestone of Pennsylvanian age 6 feet thick is reported to outcrop in the NW. cor. SE. ¼ NW. ¼ sec. 19, T. 30 N., R. 4 E., along Vermilion River and near the middle line of the south part of sec. 19, T. 30 N., R. 4 E., in a bend of Vermilion River. Similar deposits are found in the NE. cor. NW. ¼ NW. ¼ sec. 22, T. 29 N., R. 4 E., 2½ miles below Pontiac at Allen's mill and ford on Vermilion River, and at the town of Pontiac.

LOGAN COUNTY

Along Salt Creek in secs. 5, 6 and 7, T. 19 N., R. 3 W., in the vicinity of the site of Rankin's mill, there are several old quarries which expose a dense, irregularly-bedded, gray and blue-gray, Pennsylvanian limestone, containing considerable carbonaceous material. At present the quarries are filled with water, but the stone is reported to have been worked to a depth of from 10 to 20 feet.

About 3 feet of similar stone is reported to outcrop along Lake Fork in sec. 23, T. 19 N., R. 3 W.

MACON COUNTY

No outcrops of limestone are known in this county.

MACOUPIN COUNTY

Limestone 6 to 12 feet thick is reported to outcrop in the vicinity of Carlinville and along the tributaries of Macoupin Creek and also near the head waters of Cahokia Creek 2½ miles northwest of Staunton. Localities mentioned[3] in an early publication of the survey are:

1. Sec. 35, T. 10 N., R. 7 W.
2. SW. cor. NW. ¼ sec. 21, T. 9 N., R. 7 W., on Needles Creek.
3. Sec. 28, T. 9 N., R. 7 W
4. NW. ¼ sec. 31, T. 9 N., R. 7 W. on Harrington Creek.
5. Sec. 36, T. 8 N., R. 7 W., to sec. 25, T. 7 N., R. 7 W., Cahokia Creek.
6. Secs. 12 and 13, T. 7 N., R. 7 W.
7. E. ½ sec. 19, NW. ¼ sec. 20 and S. ½ sec. 17, T. 7 N., R. 7 W.
8. Secs. 24, 25 and 26, T. 7 N., R. 7 W
9. SW. ¼ sec. 30, T. 7 N., R. 6 W.

MARION COUNTY

Quantities of less than 500 tons of rock might be obtained from the 3-foot bed of limestone which outcrops along the stream valley in the SE. ¼ NE. ¼ sec. 8, T. 4 N., R. 4 E.

MARSHALL COUNTY

In the western part of Marshall County, particularly around Sparland, a thin bed of hard, light-colored Pennsylvanian limestone about four feet thick is found associated with outcrops of coal in the upper portion of the west bluff of Illinois River. Specific exposures[4] occur in the SE. ¼ sec. 14, and in the SW. ¼ NW. ¼ sec. 14, T. 12 N., R. 9 E.

MASON COUNTY

No limestone outcrops of importance are known in Mason County.

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[3]Udden, J. A., Notes on the Shoal Creek limestone: Illinois State Geological Survey Bull. 8, p. 120, 1907.

[4]Bleininger, A. V., Lines, E. F., and Layman, F. E., Portland cement resources of Illinois: Illinois State Geological Survey Bull. 17, p. 88, 1912.

McDONOUGH COUNTY[5]

The limestone outcrops in this county are of Mississipian age and are confined largely to the valleys of the major streams in the western part of the county. The St. Louis limestone and Warsaw-Spergen limestone and shale outcrop almost continuously in the bluff along Crooked Creek from the west line of the county northeast to a point almost due north of Colchester. The same formations are also exposed in Camp Creek in secs. 19 and 20, T. 4 N., R. 3 W. The St. Louis is a fine-grained, dense, blue-gray stone badly brecciated in places. The Warsaw and Spergen formations are largely shale, with interbedded impure limestone.

The Keokuk limestone outcrops in the bluffs along Panther Creek and Crooked Creek in secs. 17, 18, 19 and 20, T. 4 N., R. 4 W. Limited exposures also occur along Hogwallow Branch in secs. 32 and 33, T. 4 N., R. 4 W. The Keokuk is a blue-gray, coarse-grained, crystalline limestone containing interbedded nodules and lenses of chert.

McLEAN COUNTY

No limestone outcrops of importance are known in McLean County.

MENARD COUNTY

The following outcrops of Pennsylvanian limestone are reported in Menard County:

1. Just north of Petersburg in the west bank of the Sangamon, 3½ feet of close textured, light-drab or gray limestone is exposed.
2. Near Salem, about 2½ miles south of Petersburg, similar limestone may be found.
3. NW. ¼ sec. 36, T. 18 N., R. 7 W., in Arnold's quarry, 20 to 30 feet of light-gray or blue-gray limestone occurs in heavy beds.
4. NW. ¼ sec. 19, T. 18 N., R. 5 W. Light-colored, crinoidal limestone is found in the bed of Indian Creek.
5. NE. ¼ sec. 24, T. 18 N., R. 6 W. Heavy-bedded, gray limestone has been quarried to a depth of 7 feet. It also outcrops in creek bed for about a quarter of a mile down-stream.
6. SW. ¼ sec. 13, T. 17 N., R. 7 W., and continuing west along Rock Creek for about a mile. The limestone is gray or blue-gray in color, heavy bedded, and fossiliferous.

MONTGOMERY COUNTY

In Montgomery County, the Shoal Creek limestone, named from Shoal Creek, outcrops at several places. A few miles southeast of Litchfield along a tributary of Middle Fork, this limestone comprises the bed of the creek. Other outcrops are reported along Rocky Branch about 3 miles east of Litch-

[5]Hinds, Henry, U. S. Geol. Survey Geol. Atlas, Colchester-Macomb folio (No. 208), 1919.

field; along East Fork sec. 26, T. 8 N., R. 3 W., and also along West Fork north of the railroad. There is at present one shipping quarry within the county.

L No. 425

The Kiggins Crushed Stone Company

The quarry of the Kiggins Crushed Stone Company is located in a creek flat in the SW. ¼ sec. 2, T. 8 N., R. 5 W., about one and one-half miles east of Litchfield. The rock is Shoal Creek limestone of Pennsylvanian age. The exposure is about ten feet high and consists of about seven feet of light gray, somewhat nodular limestone in beds 3 to 10 inches in thickness underlain by about three feet of dense dark gray limestone in beds averaging about 12 inches. The limestone is underlain by gray-black shale.

The quarry is being worked as a pit. The rock is drilled with air hammers and shot down with 50 per cent dynamite. It is hand loaded into two yard cars and pulled by cable to the crusher, which is an Austin No. 5. The crushed stone is sorted by a cylindrical screen 42 inches by 20 feet with double screening at the upper end. The plant is operated by electricity. The company plans to install a hammer mill in the near future in order to produce more of the smaller sizes of stone.

The overburden consists of earth and gravel such as is left by a stream after flood water. It is removed by scrapers and dumped into piles back from the quarry face.

Transportation is furnished by the Illinois Traction System. The Cleveland, Cincinnati, Chicago and St. Louis Railway Company is about 300 feet north of the quarry. The capacity of the plant is about 350 tons per 10 hours. The product is sold for agricultural limestone, aggregate, and roads.

MORGAN COUNTY

Limestone is reported to occur in the western half of secs. 9 and 30, T. 14 N., R. 10 W.

MOULTRIE COUNTY

No limestone outcrops have been reported from this county.

PEORIA COUNTY[6]

All the limestones of Peoria County are Pennsylvanian in age. The most important is the Lonsdale which outcrops in ravines, creek valleys and old quarries in secs. 10, 11, SW. cor. sec. 3, cen. sec. 9, a little north of the

[6]Data on this county has been compiled from Geology and mineral resources of the Peoria Quadrangle by J. A. Udden, U. S. Geol. Surv. Bull. 506, p. 39, 1912, and from the report on Peoria County by A. H. Worthen and others, in Vol. V, Geological Survey of Illinois, pp. 235-252, 1873.

center of sec 30, E. ½ sec. 7, N. ½ sec 6, NE. cor. sec. 4, in T. 8 N., R. 7 E., and in secs. 31 and 32, T. 9 N., R. 7 E. The original Lonsdale quarries from which this limestone received its name are located on the south side of the Kickapoo Creek valley in sec. 14, T. 8 N., R. 7 E.

The Lonsdale limestone consists of an upper member of thin-bedded, nodular limestone about 15 feet thick and a lower member of light bluish-gray, fine-grained, compact limestone about 6 feet thick composed of beds 4 to 8 inches in thickness.

Other outcrops of limestone are reported at the following localities.

1. *Sec. 18, T. 10 N., R. 7 E.*—Fine-grained, gray, sparry limestone occurs in bed 30 inches thick.

2. *Sec. 24, T. 8 N., R. 7 E.*—Light-gray limestone may be found along Kickapoo Creek in thicknesses of 2 or 3 feet.

3. *Sec. 5, T. 10 N., R. 7 E.*—Three to four feet hard, brownish gray limestone, with thin calcite veins is exposed along Kickapoo Creek.

4. *Three miles northeast of Princeville.*—The upper 14 feet is buff, earthy, thin-bedded stone and the lower 6 feet is a crinoidal limestone.

PERRY COUNTY

Five feet of limestone is reported to outcrop in the NE. ¼ sec. 13, T. 4 S., R. 1 W. Outcrops have also been noted in a ravine in the south part of sec. 3, in sec. 4, in the east part of sec. 9, and the north part of sec. 10, T. 6 S., R. 3 W. Along Big Galum Creek, limestones outcrop in sec. 18, T. 6 S., R. 3 W., in sec. 12 and NE ¼ sec. 3, T. 6 S., R. 4 W.

PIATT COUNTY

No outcrops of limestone are known in Piatt County.

PUTNAM COUNTY

No limestone outcrops of importance are known in Putnam County.

RICHLAND COUNTY

No limestone outcrops more than 2 feet thick are reported from this county.

SANGAMON COUNTY

Four to six feet of limestone is reported to outcrop along Sugar Creek and many of the tributaries of the Sangamon in the south part of the county. On Sugar Creek it outcrops at intervals from near the Macoupin County line to about 6 miles south of Springfield.

SCHUYLER COUNTY

Outcrops of limestone are reported as follows in Schuyler County.

Pennsylvanian limestone.—A compact gray limestone, 3 to 6 feet in thickness commonly overlies the highest coal in this region and is separated from it by 2 to 4 feet of shale. The best exposures of this limestone occur in the vicinity of Rushville.

Mississippian limestone.—The St. Louis formation is exposed in the valleys of the principal streams. In the Illinois River bluff it outcrops between the south line of the county and the mouth of Sugar Creek, and is also exposed along Crooked Creek for practically its entire length in the county. The formation consists of two kinds of rock, the upper beds which are gray, concretionary limestone and the lower, brown, magnesian limestone in heavy, regular beds. Locally the lower beds are interbedded with shale or are thin-bedded, shaly limestone.

The Keokuk formation is best developed in the vicinity of Birmingham in the northwest part of the county. Its maximum exposure consists of 15 feet of thin-bedded limestone overlain by about 35 feet of calcareous shale containing numerous geodes.

SHELBY COUNTY

Four feet of limestone is reported to outcrop along Sand Creek and along Kaskaskia River, 4 to 5 miles northeast of Shelbyville.

STARK COUNTY

Outcrops of Pennsylvanian limestone are reported in secs. 21 and 22, T. 14 N., R. 7 E. The rock is compact, even textured, drab, moderately hard, in beds seldom over 3 inches thick. The exposed thickness varies from 6 to 12 feet. A quarry[7] in the SW. ¼ SE. ¼ sec. 21, has been used as a source of stone for building and paving purposes.

TAZEWELL COUNTY

A few outcrops of 2 or 3 feet of Pennsylvanian limestone overlying a like thickness of coal are reported in this county. The exposures are largely concentrated in the vicinity of Wesley and occur in the bluffs along Illinois River and in tributary ravines.

VERMILION COUNTY

The rocks exposed at the surface in this county are of Pennsylvanian age, and consist of shales and sandstones, with thin beds of limestone. In only one place is the limestone sufficiently thick to warrant quarrying, namely, at Fairmount.

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[7]Bleininger, A. V., Lines, E. F., and Layman, F. E., Portland cement resources of Illinois: Ill. State Geol. Survey Bull. 17, 1912.

Fig. 65. Birds-eye view of the Fairmount quarry of the Illinois Steel Company.

L No. 100

The Fairmount quarry of the Illinois Steel Company

Secs. 16, 17, 20, and 21, T. 18 N., R. 13 W.

This quarry (fig. 65) is roughly oval in shape, about 2 miles long, and 1¼ miles wide. The face ranges from 16 to 20 feet in height and the rock is capped by overburden having similar thickness.

The limestone is hard, dense, in thin beds from 1 to 20 inches in thickness, and contains numerous, small masses of crystalline calcite. The stone is blue-gray in color on a fresh surface, but buff or dirty-gray along the joint planes or horizontal cracks. The character of the stone varies somewhat throughout the quarry. That at the east end is the thickest-bedded. The limestone is underlaid by carbonaceous shales.

The stripping is done by means of steam shovels which overcast the till overburden behind the working face. Three pumps, two steam and one electric, keep the quarry dry and discharge the water into a nearby creek. The blast holes are drilled by three Ingersoll-Rand churn drills and six tripod drills of the same make. The entire face is shot down at one time, 15 or 20 holes being fired simultaneously with 35 per cent dynamite. The broken stone is loaded by steam shovel (fig. 66) into 6-, 8- and 12-yard quarry cars, and pulled by a locomotive to the crusher.

The crusher is a 36 by 60-inch Allis-Chalmers Fairmount roll which reduces the rock to 6-inch size. From the rolls the crushed rock runs into skips (fig. 67) which transfer it to the screens where it is sorted into oversize, 3 inches, 1¼ inches, and agricultural size. The screens are four in number and of Allis-Chalmers make, size 18 by 4 feet (fig. 68). From the screens, the stone goes to the bins which have a capacity of about 6 cars, (fig. 69). The plant is electrically operated by current from two Allis-Chalmers generators, driven by a steam engine. A rather extensive system of water softening has been installed, to prevent the formation of scale in the boiler of the engine.

The daily production of the quarry is about 5000 tons; the yearly production 1,250,000 tons.

The stone is used by the Illinois Steel Company as a flux in the smelting of iron ore. Small amounts of the fine stone are sold for agricultural limestone but most of it is used for the manufacture of cement. The company has a switch to the Elgin, Joliet and Eastern Railroad, and is ½ mile from the main line.

WABASH COUNTY

Three feet of dark, argillaceous and bituminous limestone is reported to outcrop about 3 miles northeast of Mt. Carmel.

FIG. 66. Steam shovel loading Pennsylvanian limestone at the Fairmount quarry of the Illinois Steel Company.

FIG. 67. The skips which take the broken rock from the primary rolls to the screens and secondary crushers at the Fairmount quarry.

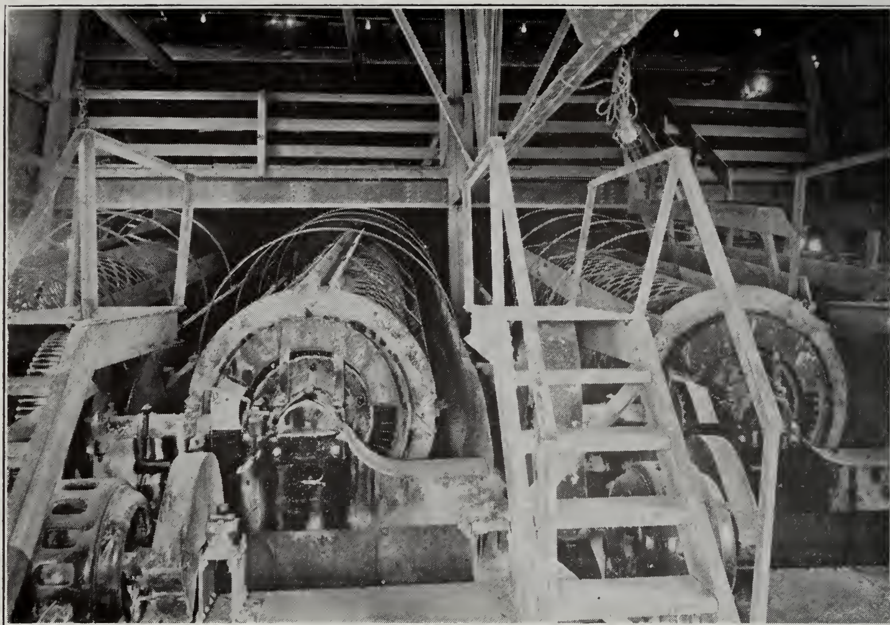

Fig. 68. Cylindrical screens at the Fairmount quarry.

Fig. 69. Crushing plant and storage bins at the Fairmount quarry.

WARREN COUNTY

The Burlington formation is the most important limestone outcropping in this county. It consists of a light-gray and brown limestone with some interbedded sandstone, shale and chert. Its outcrops are confined to the western part of the county and some of the more important exposures reported are listed below.

1. *T. 12 N., R. 3 W.*—Along the small streams in secs. 31, 32, 33 and 35. (Cedar Creek.)
2. *T. 12 N., R. 3 W.*—Continuous bluff along Cedar Creek from Rockwell's mill to Olmstead's mill, T. 11 N., R. 2 W.
3. *T. 12 N., R. 2 W.*—Along some of the small streams in secs. 19, 20, 29 and 30. Overlain by thin Pennsylvanian strata.
4. *T. 11 N., R. 3 W.*—Along some of the streams in secs. 1, 4, 5 and 8.
5. *T. 11 N., R. 2 W.*—Extensive outcrop along small creek near middle of sec. 7.
6. *T. 11 N., R. 2 W.*—Extensive outcrops along small creek in E. ½ sec. 8.
7. *T. 11 N., R. 2 W.*—Along small creek in sec. 16.
8. *T. 9 N., R. 1 W.*—Small outcrop in sec. 24.

WASHINGTON COUNTY

In Washington County about 5 feet of hard, compact, dark-gray limestone is exposed along several of the creeks, and some of these localities will probably furnish more than 500 tons. A partial list of outcrops follows:

1. Along the creek at the cen. of SE. ¼ sec. 18, T. 1 S., R. 2 W.
2. Along the creek at the cen. NE. ¼ sec. 21, T. 3 S., R. 1 W.
3. On Beaucoup Creek in secs. 26, 34 and 35, T. 2 S., R. 2 W.
4. At the head of Neaterling Branch, in the cen. SE. ¼ sec. 31, T. 2 S., R. 2 W.
5. NE. ¼ NE. ¼ sec. 16, T. 1 S., R. 3 W., along a small branch.
6. Sec. 35 at junction of two creeks

WAYNE COUNTY

No outcrops of limestone more than 2 feet thick are reported from this county.

WHITE COUNTY

No limestone outcrops are reported for this county.

WILLIAMSON COUNTY

In Williamson County a bed of limestone 2 to 4 feet thick overlies the coal at the center of sec. 30, T. 9 S., R. 4 E. It is reported that a large company contemplates stripping the coal, and if this is done several thousand tons of compact gray limestone will be made available.

WOODFORD COUNTY

Limestone of Pennsylvanian age is reported to outcrop in Woodford County as follows:

Three feet of compact stone occur about 4 miles northwest of Metamora in sec. 1, T. 27 N., R. 3 W., along Partridge Creek.

Limestone 8 to 12 feet thick, bluish-gray in color may be found in a small quarry southwest of Secor in secs. 23 and 24, T. 26 N., R. 1 E.

Stone similar to preceding is found in a small quarry in sec. 33, T. 26 N., R. 1 E.

CHAPTER XI.—CHEMICAL ANALYSES OF ILLINOIS LIMESTONES AND DOLOMITES

By J. E. Lamar

The uses of limestones and dolomites have become so varied that much importance attaches to their chemical composition. The accompanying tables of average and detailed chemical analyses (Tables 16 and 17) of Illinois limestones have been compiled from various publications, with the addition of new analyses made by the Illinois State Highway Testing Laboratory. The samples for these latter analyses were collected in connection with the highway material samples.

TABLE 16.—*Average chemical analyses of Illinois limestones and dolomites*

Formation	Number of samples	Calcium carbonate	Magnesium carbonate	Total calcium carbonate equivalent[a]
Pennsylvanian system				
Clark County (Undifferentiated)	6	92.7	1.84	94.9
LaSalle County (LaSalle limestone)	33	80.4	3.4	84.4
Peoria County (Lonsdale limestone)	6	79.8	1.49	81.6
Schuyler County (Undifferentiated)	3	86.8	1.81	89.0
McLeansboro (General average)	18	88.2	2.55	91.2
Mississippian system				
Menard limestone	6	92.2	2.4	95.0
Okaw limestone	11	91.6	3.2	95.4
Golconda limestone	3	90.5	3.0	94.1
Renault limestone	2	91.3	1.4	93.0
Ste. Genevieve limestone	13	90.6	2.91	94.0
St. Louis limestone	24	93.2	2.41	96.1
Salem limestone	12	76.65	4.86	82.4
Keokuk limestone	8	73.3	3.7	77.7
Burlington limestone	8	96.4	2.37	97.2
Devonian system				
Hamilton limestone	6	85.3	4.21	90.3
Silurian system				
Niagaran dolomite				
Cook County	28	53.3	42.55	103.8
Joliet	9	49.7	38.6	95.5
Kankakee	6	48.7	36.9	92.5
Ordovician system				
Platteville limestone	16	69.0	21.1	94.0
Galena dolomite	5	51.7	40.9	100.2
Kimmswick limestone	3	97.7	2.08	100.2
Shakopee dolomite	8	55.78	33.2	95.1

[a]Total calcium carbonate equivalent equals the amount of calcium carbonate, plus the amount of calcium carbonate equivalent in neutralizing power to the amount of magnesium carbonate shown in the table.

TABLE 17.—*Detailed chemical analyses of*

County	Sample Number	Location	Operator or owner	Authority
Adams[a]		Marblehead	Marblehead Lime Co.	N. Gray Bartlett, Chicago.
		Marblehead	Marblehead Lime Co.	Wm. Brady
		Marblehead	Marblehead Lime Co.	Wm. Brady
Adams[b]	C 15	W side sec. 11, T. 2 S., R. 9 W.		
	C 16	SW. ¼, sec. 26, T. 1 S., R. 9 W.		
	C 17	NW. ¼, sec. 11, T. 1 N., R. 7 W.		
Adams[c]		Marblehead	Marblehead Lime Co.	U. S. Geological Survey
		Marblehead	Marblehead Lime Co.	Atlas Portland Cement Co.
Adams[k]		Quincy		Henry Pratten
		Quincy		Henry Pratten
Adams[u]		Quincy	F. W. Menke Stone and Lime Co.	C. G. Hopkins
Alexander[b]	D 42	Sec. 17, T. 15 S., R. 3 W.		F.W. Pate
Alexander[m]		Grand Chain, S. of Thebes		Henry Pratten
Boone[a]		Belvidere	Electric Stone Co.	W. W. Daniels, University of Wisconsin
		Belvidere	Electric Stone Co.	W. W. Daniels, University of Wisconsin
Brown[b]	C 18	SE. cor. sec. 6, T. 2 S., R. 3 W.		
	C 19a	NW. ¼, sec. 18, T. 2 S., R. 3 W.		
	C 19b	NW. ¼, sec. 18, T. 2 S., R. 3 W.		
	C 19c	NW. ¼, sec. 18, T. 2 S., R. 3 W.		
	C 20	NW. ¼, sec. 26, T. 2 S., R. 3 W.		
	C 21b	NW. ¼, SE. ¼, sec. 20, T. 2 S. R. 3 W.	Elijah Surratt	
	C 22	Sec. 17, T. 2 S., R. 3 W.	L. M. Surratt, Surratt Hollow	
	C 23	Sec. 18, T. 2 S., R. 3 W.		
	C 24	NE. ¼, sec. 20, T. 2 S., R. 3 W.		
	C 25	NE. ¼, SE. ¼, sec. 3, T. 2 S., R. 2 W.		
	C 26	SE. cor. sec. 15, T. 1 N., R. 2 W.		
	C 27	SE. ¼, SE. ¼, sec. 15, T. 1 N., R. 2 W.		
	C 28	SW. ¼, sec. 4, T. 1 N., R. 2 W.		
Bureau[b]	C 11a	SW. ¼, NE. ¼, sec. 33, T. 16 N., R. 11 E.		
	C 11b	SW. ¼, NE. ¼, sec. 33, T. 16 N., R. 11 E.		
	E 15a	Sec. 31, T. 16 N., R. 11 E.		
Carroll[a]		Mount Carroll	G. E. Hungerford	
Clark[b]	S 9	NE. ¼, sec. 28, T. 10 N., R. 14 W.		
	S 51a	NW. ¼, sec. 6, T. 11 N., R. 11 W.		
	S 51c	NW. ¼, sec. 6, T. 11 N., R. 11 W.		
	S 52a	NW. ¼, sec. 29, T. 11 N., R. 11 W.	Frederick Stump, Marshall, Ill.	

Illinois limestones and dolomites

Geologic formation	$CaCO_3$	$MgCO_3$	CaO	MgO	CO_2	Fe_2O_3	Al_2O_3	SiO_2	Other mineral constituents	Volatile matter	Loss on ignition	H_2O at 105°C
Burlington	95.62	.82	......	......	......	2.18		.47	Undetermined, 0.91 per cent	......	......	......
Burlington	97.40	1.40	......	......	......	.12	.68	.40	......	......	......	......
Burlington	97.51	1.30	......	......	......	.12	.52	.50	......	......	......	......
Burlington	77.47	1.76	43.42	.84	......	1.94		19.78	......	......	35.10	.30
Keokuk	86.32	1.42	48.38	.68	......	1.54		9.66	......	......	39.90	.26
Salem	79.33	1.96	44.46	.94	......	3.92		12.26	......	......	37.24	.23
Burlington	98.45	1.28	......	......	......	.10	.04	.21	......	......	......	......
Burlington	98.97	Trace	......	......	......	1.22		.36	......	......	......	......
Burlington	94.68	4.31	......	......	......	0.20		......	Insoluble matter, 0.05	......	......	.76
Burlington	71.00	24.00	......	......	......	4.00		......	Insoluble matter, 1.00	......	......	......
Burlington	92.77	6.75	......	......	......	0.27		0.37	......	......	......	......
Kimmswick	99.62	1.18	55.83	.55	......	.32		.27	......	......	......	.01
Kimmswick	98.01	1.59	......	......	......	Trace	.20	......	Insoluble matter .06; Moisture, 1.07	......	......	......
Galena	52.27	44.67	......	......	......	.98		1.87	......	......	......	......
Galena	54.59	41.33	......	......	......	.85		2.90	......	......	......	......
Salem	94.39	1.34	52.90	.64	......	1.46		2.96	......	......	42.70	.16
Salem	43.36	18.56	24.30	8.88	......	10.36		26.46	......	......	30.84	.22
Salem	29.87	1.42	16.74	.68	......	10.80		56.64	......	......	14.76	.39
Salem	89.39	.79	50.10	.38	......	2.40		7.26	......	......	40.10	.15
Salem	78.30	1.13	43.88	.54	......	3.06		16.90	......	......	35.98	.31
Salem	80.86	1.05	45.32	.50	......	3.10		15.40	......	......	36.40	.40
Salem	82.36	1.17	46.16	.56	......	3.10		13.54	......	......	37.26	.07
Salem	86.82	1.25	48.66	.60	......	2.40		8.78	......	......	39.62	.18
Salem	90.18	1.25	50.54	.60	......	1.90		6.44	......	......	40.74	.16
Salem	69.59	20.07	39.00	9.60	......	3.98		5.80	......	......	42.20	.33
Salem	78.90	7.81	44.22	3.74	......	3.92		8.36	......	......	40.04	.26
Salem and St. Louis	87.43	3.01	49.00	1.44	......	2.64		6.62	......	......	40.82	.20
St. Louis	88.89	2.51	49.82	1.20	......	2.42		5.86	......	......	41.02	.23
LaSalle	51.42	11.16	28.82	5.34	......	11.00		26.18	......	......	29.56	.22
LaSalle	55.67	5.89	31.20	2.82	......	11.10		22.76	......	......	32.78	.41
LaSalle	60.42	6.19	33.86	2.96	......	8.64		23.30	......	......	32.38	.46
Galena	54.06	43.68	......	......	......	1.12		1.62	......	......	......	......
Quarry Creek	91.46	1.38	51.26	.66	......	2.94		4.04	......	......	41.92	.17
Quarry Creek	94.46	1.11	52.94	.53	......	2.26		1.74	......	......	43.18	.14
Quarry Creek	95.00	1.44	53.24	.69	......	1.56		2.12	......	......	43.16	.08
McLeansboro	96.10	1.15	53.86	.55	......	1.62		1.46	......	......	43.16	.03

TABLE 17.—*Detailed chemical analyses of*

County	Sample Number	Location	Operator or owner	Authority
Clark[b]	S 52b	NW. ¼, sec. 29, T. 11 N., R. 11 W.	Frederick Stump, Marshall, Ill.	
		SE. ¼, sec. 19, T. 9 N., R. 11 W.	Illinois Limestone Co.	University of Illinois, Urbana
Coles[b]	S 3	NW. ¼, sec. 5, T. 12 N., R. 10 E		F. W. Pate
	B 10	Charleston		
Cook[a]		Chicago	Artesian Stone & Lime Co.	T. C. Hopkins, State College, Pa.
		Chicago	Artesian Stone & Lime Co.	T. C. Hopkins, State College, Pa.
		Chicago	Chicago Union Lime Works Co.	J. Blodget Britton, Warrenton, Va.
		Chicago	Chicago Union Lime Works Co.	J. Blodget Britton, Warrenton, Va.
		Chicago	Stearns Lime & Stone Co.	T. C. Hopkins, State College, Pa.
		Gary	Dolese & Shepard Co.	Chemist, Illinois Steel Co.
		Gary	Dolese & Shepard Co.	Chemist, Illinois Steel Co.
		Hawthorne	Dolese & Shepard Co.	Chemist, Illinois Steel Co.
		McCook	U. S. Crushed Stone Co.	Laboratory, Inland Steel Co.
		McCook	U. S. Crushed Stone Co.	Laboratory, Inland Steel Co.
		McCook	U. S. Crushed Stone Co.	Laboratory, Inland Steel Co.
		McCook	U. S. Crushed Stone Co.	Laboratory, Inland Steel Co.
		McCook	U S. Crushed Stone Co.	Laboratory, Inland Steel Co.
		Summit	U. S. Crushed Stone Co.	Chemist, Illinois Steel Co.
		Thornton	Brownell Improvement Co.	Dickman & Mackenzie
		Thornton	Brownell Improvement Co.	Dickman & Mackenzie
Cook[d]		1 mi. southeast of Blue Island.		
Cook[e]	Average 18 analyses	Hawthorne	Dolese & Shepard Co.	Illinois Steel Co.
		Thornton	Brownell Improvement Co.	U. S. Geol. Survey structural materials laboratories

Illinois limestones and dolomites—Continued

Geologic formation	$CaCO_3$	$MgCO_3$	CaO	MgO	CO_2	Fe_2O_3	Al_2O_3	SiO_2	Other mineral constituents	Volatile matter	Loss on ignition	H_2O at 105°C
McLeansboro......	82.11	4.10	46.02	1.96	......	5.50		6.26	....	......	40.78	.22
McLeansboro......	97.22	......	53.28	Trace	......	1.10		1.59	....	......	43.80	......
McLeansboro......	93.41	2.47	52.35	1.18	......	1.56		3.90	....	......	......	.126
McLeansboro......	59.95	10.05	......	......	......	5.08		......	Insoluble matter 24.48; Phosphorus, 0.45........	......	......	......
Niagaran.........	53.70	42.34	......	......	......	1.04		1.28	Average of quarry...........	......	......	......
Niagaran.........	52.07	42.18	......	......	......	1.78		4.00	Lumpy layer....	......	......	......
Niagaran.........	52.76	45.04	......	......	......	1.48		.21	....	......	......	.51
Niagaran.........	54.21	44.65	......	......	......	.66		.12	....	......	......	.36
Niagaran.........	52.75	44.28	......	......	......	.55		.60	....	......	......	......
Niagaran.........	53.09	43.82	......	......	......	1.96		1.42	....	......	......	......
Niagaran.........	......	......	31.20	20.46	46.58	......	.43	.94	Fe, 0.36; P, 0.004; S, 0.031			
Niagaran.........	......	......	30.74	22.61	44.54	.35	.67	1.05	SO_3, .036; P_2O_5, .004......	......	......	......
Niagaran.........	55.30	43.95	......	......	......	0.20		0.36	....	......	......	......
Niagaran.........	55.12	44.27	......	......	......	.36		.30	....	......	......	......
Niagaran.........	55.30	43.95	......	......	......	.30		.28	....	......	......	......
Niagaran.........	55.65	43.61	......	......	......	.30		.26	....	......	......	......
Niagaran.........	55.61	43.95	......	......	......	.36		.24	....	......	......	......
Niagaran.........	......	......	30.22	19.70	45.74	.36	1.33	2.58	SO_3, 0.059; P_2O_5, 0.007....	......	......	......
Niagaran.........	52.44	43.66	......	......	......	.85		2.35	Organic matter, 0.60..........	......	......	......
Niagaran.........	52.67	43.57	......	......	......	.85		2.10	Organic matter, 0.72..........	......	......	......
Niagaran.........	31.60	22.24	......	......	......	1.20	....	.16	Clay & insoluble matter, 43.56; Alkalinity, loss, etc., 1.30......	......	......	......
Niagaran.........	54.73	42.79	......	......	......	0.83	0.91	1.12	P, 0.005; S, 0.04.........	......	......	......
Niagaran.........	54.04	42.96	......	......	......	.37	.55	1.23	MnO, 0.03; Na_2O, 0.19; K_2O, 0.14;..... SO_3, Tr., H_2O, 0.29	......	......	......

TABLE 17.—*Detailed chemical analyses of*

County	Sample Number	Location	Operator or owner	Authority
Cook[e]		Thornton	Brownell Improvement Co.	U. S. Geol. Survey structural materials laboratories
		LaGrange	Federal Stone Co	Mariner & Hoskins, Chicago
		LaGrange	Federal Stone Co	Featherstone Foundry Co., Chicago
	Average 36 analyses	McCook	Dolese & Shepard Co.	Illinois Steel Co, Chicago
	Average 6 analyses	McCook	U. S. Crushed Stone Co.	Illinois Steel Co., Indiana Harbor
	Average 27 analyses	Gary	Dolese & Shepard Co.	Illinois Steel Co., Chicago
		Lemont	Western Stone Co	J. V. Z. Blaney
	Average analyses.	Romeo	Joliet Flux Stone Co	
	Average analyses	Romeo	Joliet Flux Stone Co	
Cook[l]		Blue Island		J. V. Z. Blaney
Cook[u]		Chicago	Union Lime Co	T. C. Hopkins
		Chicago	Stearns Stone & Lime Co.	T. C. Hopkins
	Average of quarry	Chicago	Artesian Stone & Lime Co.	T. C. Hopkins
	Lumpy layer	Chicago	Artesian Stone & Lime Co.	T. C. Hopkins
		Chicago	Stony Island Ave. quarry	T. C. Hopkins
	Insoluble portion of stone	Chicago	Blue Island quarry	T. C. Hopkins
Cook[l]	Top strata	Gary	Dolese & Shepard Co.	Cement, Mill & Quarry, May 5, 1922, p. 20
Edgar[b]	Bu 2	NE. ¼, sec. 3, T. 15 N., R. 12 W	David Tucker & Geo. Triplet	
	S 50a	SE ¼, NE. ¼, sec. 10, T. 14 N., R. 11 W		
	S 50c	SE. ¼, NE. ¼, sec. 10, T. 14 N., R. 11 W		
Greene[l]		4 mi. SE. of Carrollton		J. V. Z. Blaney
		NE. ¼, sec. 10, T. 11 N., R. 11 W		J. V. Z.Blaney

Illinois limestones and dolomites—Continued

Geologic formation	$CaCO_3$	$MgCO_3$	CaO	MgO	CO_2	Fe_2O_3	Al_2O_3	SiO_2	Other mineral constituents	Volatile matter	Loss on ignition	H_2O at 105°C
Niagaran.........	33.50	27.95	......	......	......	1.62	5.63	27.27	MnO, .02; Na₂O, .02; K_2O, 2.94; SO_3, Tr., H_2O .26..........	......	......	......
Niagaran.........	59.40	39.80	......	......	......	.40		.40	P., Tr.; S., .04	......	......	......
Niagaran.........	53.41	45.22	......	......	......	.90	....	.70	....	......	......	......
Niagaran.........	54.82	43.13	......	......	......	.80	.86	1.04	....	......	......	......
Niagaran.........	55.38	43.93	......	......	......	.31		.28	....	......	......	......
Niagaran.........	54.68	42.84	......	......	......	.86	.93	1.10	....	......	......	......
Niagaran.........	36.00	41.00	......	......	......	.96	1.33	17.30	H_2O, 1.00.......	......	......	......
Niagaran.........	53.73	42.13	......	......	......	1.15	.63	1.99	P, .014..........	......	......	......
Niagaran.........	52.61	41.84	......	......	......	2.08	.64	1.90	P, .012; S, .054..	......	......	......
Niagaran.........	31.60	22.24	......	......	......	1.20	....	......	Clay & insoluble matter, 43.56 Soluble silica, .16..........	......	1.30	......
Niagaran.........	54.99	44.04	......	......	......	0.58		......	Insoluble 0.87;...	......	......	......
Niagaran.........	52.75	44.28	......	......	......	0.55		......	Insoluble, 0.60...	......	......	......
Niagaran.........	53.70	42.34	......	......	......	1.04		......	Insoluble, 1.28...	......	......	......
Niagaran.........	52.07	42.18	......	......	......	1.78		......	Insoluble, 4.00...	......	......	......
Niagaran.........	52.08	37.54	......	......	......	......	......	......	....	......	......	......
Niagaran.........	......	......	1.03	......	......	15.70		75.35	Organic matter, moisture and alkalies, 8.55....	......	......	......
....	......	......	30.26	21.30	47.11	0.26	0.61	0.42	Phosphorus, 0.005 sulphur, 0.026; moisture, 0.009	......	......	......
McLeansboro......	92.62	2.97	51.90	1.42	......	2.34		2.66	....	......	42.00	.22
McLeansboro......	95.96	1.21	53.78	.58	......	1.74		1.52	....	......	43.18	.04
McLeansboro.....	82.61	2.82	46.30	1.35	......	5.52		8.02	....	......	38.98	.25
St. Louis.........	44.90	25.44	......	......	......	5.21		......	Clay & insoluble matter, 23.49;	......	......	.96
St. Louis.........	30.70	16.31	......	......	......	2.75		......	Clay & insoluble matter, 48.53.	......	.49	......

TABLE 17.—*Detailed chemical analyses of*

County	Sample Number	Location	Operator or owner	Authority
Hancock[b]	C 38	Sec. 30, T. 5 N., R. 8 W.		
	C 40	NW. ¼, sec. 14, T. 7 N., R. 8 W.		
	C 41	SE. ¼, sec. 16, T. 7 N., R. 8 W.		
	C 42	SE. cor. sec. 12, T. 6 N., R. 8 W.		
Hancock[a]		Niota	Fort Madison & Appanoose Stone Co.	J. C. Cary
Hancock[g]		Nauvoo		Mr. Pratten
	W 81	Warsaw	Mr. Grover	
Hardin[b]	W 322	SW. ¼, sec. 27, T. 12 S., R. 8 E.		
	W 330	SW. ¼, sec. 5, T. 13 S., R. 8 E.		
Hardin	K x	Sec. 35, T. 12 S., R. 8 E.		Ill. State Highway Laboratory
Hardin[o]		Rosiclare		Henry Pratten
Henderson[b]	C 39	Sec. 22, T. 8 N., R. 6 W.	C. E. Lowry	
Jackson[b]	S 5	NE. ¼, sec. 25, T. 10 S., R. 4 W.		
	S 57a	NW. ¼, sec. 25, T. 10 S., R. 4 W		
Jackson	L 80	NW. ¼, NW. ¼, sec. 34, T. 8 S., R. 4 W.		Ill. State Highway Laboratory
	L 90	Cen. sec. 24, T .10 S., R. 3 W.	Mr. Faulkner, Grand Tower	Ill. State Highway Laboratory
	L 91	Cen. sec. 24, T. 10 S., R. 3 W.	McCann Bros., Murphysboro	Ill. State Highway Laboratory
	L 92	Cen. sec. 24, T. 10 S., R. 3 W.	McCann Bros., Murphysboro	Ill. State Highway Laboratory
Jackson[l]		Bald Rock		J. V. Z. Blaney
Jersey[a]		Grafton	Grafton Quarry Co.	Ill. Geological Survey
Jersey[j]		Grafton		Henry Pratten
Jersey[l]		Grafton		J. V. Z. Blaney
Jo Daviess[f]		Cen. S. ¼, sec. 34 T. 29 N, R. 1 E.		
Johnson	K 29	S. Cen. sec. 16, T. 12 S., R. 3 E.		Ill. State Highway Laboratory
Johnson[b]	D 16	Sec. 1, T. 14 S., R. 2 E.		
	D 17	Sec. 1, T. 14 S., R. 2 E.		
	W 304	SW. ¼, sec. 5, T. 14 S., R. 2 E.		
	W 308	Middle W. ½, sec. 16, T. 13 S., R. 3. E.		
Johnson[p]	D 16	Belknap, along Big Four tracks		F. W. Pate
	D 17	Belknap, along Big Four tracks		F. W. Pate
Johnson		Near Joppa Junction		

Illinois limestones and dolomites—Continued

Geologic formation	$CaCO_3$	$MgCO_3$	CaO	MgO	CO_2	Fe_2O_3	Al_2O_3	SiO_2	Other mineral constituents	Volatile matter	Loss on ignition	H_2O at 105°C
Keokuk	69.16	4.18	38.76	2.00	......	3.34		23.24	......	......	33.40	.28
St. Louis	95.67	.79	53.62	.38	......	1.48		2.62	......	......	42.48	.13
Keokuk	86.08	1.21	48.24	.58	......	2.36		10.20	......	......	38.94	.24
Keokuk	74.66	5.23	41.84	2.50	......	3.80		16.24	......	......	35.98	.28
......	53.93	36.59	......	......	......	2.65		4.69 1.61*	......	......	......	0.21
Nauvoo	82.48	......	......	......	......	2.10		......	Insoluble matter, 12.50	......	......	2.92
Keokuk	92.89	1.92	52.07	.92	......	0.93		4.18	......	......	......	......
St. Louis	80.43	7.56	45.08	3.62	......	2.14		9.10	......	......	40.18	.18
Ste. Genevieve	85.82	2.21	48.10	1.06	......	4.10		7.78	......	......	39.72	.33
Fredonia limestone	83.20	8.31	......	......	......	2.41		5.54	......	......	......	......
St. Louis	90.86	3.18	......	......	......	1.06		......	Insoluble matter, 2.72; Moisture, 0.15	......	......	2.03
Burlington or Keokuk	96.71	.71	54.20	.34	......	1.12		2.30	......	......	43.06	.08
Onondaga	93.21	2.63	52.24	1.26	......	1.12		3.08	......	......	42.62	.14
New Scotland	93.93	4.89	52.64	2.34	......	.72		.86	......	......	43.92	.07
Chester	93.30	2.28	......	......	......	1.73		2.27	......	......	......	......
St. Louis-Salem	96.48	1.83	......	......	......	0.70		0.98	......	......	......	......
St. Louis-Salem	94.76	1.83	......	......	......	1.34		1.71	......	......	......	......
St. Louis-Salem	94.66	2.60	......	......	......	0.97		1.34	......	......	......	......
Oriskany	37.25	60.00	......	......	......	.80		......	Clay & soluble matter, 1.56	......	.39	......
Niagaran	47.79	42.86	......	......	......	1.40		5.60	......	......	......	2.35
Niagaran	50.15	42.20	......	......	......	2.10		......	Insoluble matter, 5.15	......	.40	......
Hamilton	59.30	16.08	......	......	......	1.00		......	Clay & insoluble matter, 23.13	......	.49	......
Decorah shale or Platteville ls.	85.54	3.98	......	......	......	.95	2.26	6.16	P_2O_5, .055	......	......	.93
Kinkaid	91.45	3.10	......	......	......	0.74		4.74	......	......	......	......
Ste. Genevieve	90.17	4.33	59.87	1.75	......	1.32		6.00	......	......	......	......
Ste. Genevieve	92.90	2.38	52.06	1.14	......	.83		5.32	......	......	......	......
Ste. Genevieve	94.07	3.14	52.72	1.50	......	1.22		2.04	......	......	43.34	.12
Chester	95.57	1.55	53.56	.74	......	1.76		.96	......	......	43.20	11
Renault	90.31	1.40	......	......	......	1.315		......	Insoluble, 5.996; phosphorus, .038	......	......	......
Renault	92.36	......	......	......	......	.892		......	Insoluble, 5.328; phosphorus .023	......	......	......
Ste. Genevieve	94.96	1.58	......	......	......	1.50		1.73	......	......	......	......

TABLE 17.—*Detailed chemical analyses of*

County	Sample Number	Location	Operator or owner	Authority
Johnson........	....	....	....	....
	....	....	....	....
	....	....	....	....
	....	....	....	....
	....	....	....	....
	....	....	....	....
Kane........	L 157	SE. ¼, NE. ¼ sec. 27, T. 39 N., R. 8 E........	John Hendrickson, Batavia	Ill. State Highway Laboratory........
Kane[l]........	....	4 mi. N. of St. Charles........	....	J. V. Z. Blaney........
Kankakee[a]........	....	Kankakee........	Kankakee Quarries Co....	Chemist, Ill. Steel Co.....
	....	Kankakee........	Lehigh Stone Co........	Pittsburgh Testing Laboratory........
	....	Kankakee........	Lehigh Stone Co........	Robt. W. Hunt & Co......
	....	Kankakee........	Lehigh Stone Co........	Robt. W. Hunt & Co......
	....	Kankakee........	Lehigh Stone Co........	Robt. W. Hunt & Co......
Kankakee........	L 107	SE. ¼,NE. ¼, sec. 20, T. 32 N., R. 12 E........	Luther Smith,Manteno, Ill.	Ill. State Highway Laboratory........
	L 108	NW. ¼, sec. 7, T. 30 N., R. 14 W	Lehigh Stone Co........	Agri. Exp. Station, Univ. of Ill........
LaSalle[b]........	C 2a	Sec. 15, T. 33 N., R. 3 E.......	German American Portland Cement Co........	....
	C 2c	Sec. 15, T. 33 N., R. 3 E.......	German American Portland Cement Co........	....
	C 2d	Sec. 15, T. 33 N., R. 3 E.......	German American Portland Cement Co........	....
	C 3a	Sec. 6, T. 32 N., R. 2 E.......	Marquette Portland Cement Co........	State Geol. Survey.......
	C 3b	Sec. 6, T. 32 N., R. 2 E.......	Marquette Portland Cement Co........	State Geol. Survey.......
	C 3d	Sec. 6, T. 32 N., R. 2 E.......	Marquette Portland Cement Co........	State Geol. Survey........
	C 9	NW. ¼, sec.11, T. 33 N., R.1 E.	....	State Geol. Survey........
	C 10	SE. ¼, sec. 34, T. 34 N., R. 1 E.	....	State Geol. Survey........
	C 12a	Near cen. sec. 6, T. 32 N., R. 2 E	Bailey Falls........	....
	C 12b	Near cen. sec. 6, T. 32 N., R. 2 E	Bailey Falls........	....
	C 13	SW. ¼, sec. 30, T. 33 N., R. 1 E.	....	....
	C 14a	SW. cor. sec. 8, T. 33 N., R. 2 E.	Illinois Hydraulic Cement Mfg. Co........	State Geol. Survey........
	C 14b	SW. cor. sec. 8, T. 33 N., R. 2 E.	Illinois Hydraulic Cement Mfg. Co........	State Geol. Survey........
	E 1a	SE. ¼, NW. ¼, sec. 14, T. 33 N. R. 1 E........	German American Portland Cement Co........	....
	E 1c	SE. ¼, NW. ¼, sec. 14, T. 33 N. R. 1 E........	German American Portland Cement Co........	State Geol. Survey........

Illinois limestones and dolomites—Continued

Geologic formation	$CaCO_3$	$MgCO_3$	CaO	MgO	CO_2	Fe_2O_3	Al_2O_3	SiO_2	Other mineral constituents	Volatile matter	Loss on ignition	H_2O at 105°C
Ste. Genevieve....	81.38	1.74	......	......	......	4.05		13.16	....	......	......	......
Ste. Genevieve....	95.70	2.04	......	......	......	.80		1.28	....	......	......	......
Ste. Genevieve....	94.58	2.73	......	......	......	2.25		.28	....	......	......	......
Ste. Genevieve....	93.82	1.25	......	......	......	2.60		1.85	....	......	......	......
Ste. Genevieve....	86.56	3.99	......	......	......	3.80		4.66	....	......	......	......
Ste. Genevieve....	94.00	1.67	......	......	......	1.45		2.26	....	......	......	......
Niagaran.........	48.28	38.00	......	......	......	4.52		6.34	....	......	......	......
Niagaran.........	40.86	43.54	......	......	......	1.40	......	......	Clay & insoluble matter, 11.60;...	......	2.60	......
Niagaran.........	......	......	30.45	20.50	43.544	2.50		3.00	P, 0.006........	......	......	......
Niagaran.........	46.18	35.05	......	......	......	1.19	4.28	10.78	P, 0.02; S, trace.	......	2.50	......
Niagaran.........	50.80	40.40	......	......	......	3.00	5.50	......	H_2O & P, 0.30..	......	......	......
Niagaran.........	47.73	35.86	......	......	......	1.12	4.35	10.30	....	......	......	......
Niagaran.........	51.07	40.62	......	......	......	1.64	1.48	5.00	....	......	......	......
Niagaran.........	44.50	35.13	......	......	......	6.10		11.36	....	......	......	......
Niagaran.........	51.7	40.8	......	......	......	1.2		......	Soluble matter, 6.1..........	......	......	......
La Salle..........	92.39	1.44	51.78	.69	......	2.24		2.88	....	......	42.06	.14
La Salle..........	82.22	4.10	46.08	1.96	......	4.76		8.78	....	......	39.26	.15
La Salle..........	81.33	2.88	45.58	1.38	......	4.40		10.34	....	......	37.88	.80
La Salle (roof rock)	95.14	1.57	53.32	.75	......	1.56		1.98	....	......	42.66	.12
La Salle (upper part of lower bed)....	85.68	1.42	48.02	.68	......	4.80		7.94	....	......	39.48	.28
La Salle (lower part of lower bed)....	85.15	2.74	47.72	1.31	......	3.40		8.24	....	......	38.90	.25
La Salle..........	85.36	1.38	47.84	.66	......	5.92		6.72	....	......	40.20	.12
La Salle..........	77.55	2.42	43.46	1.16	......	7.84		11.10	....	......	37.38	.24
La Salle..........	93.36	1.21	52.32	.58	......	1.90		2.66	....	......	42.66	.14
La Salle..........	74.12	2.38	41.54	1.14	......	7.58		15.24	....	......	35.58	.49
La Salle..........	44.64	13.17	25.02	6.30	......	16.36		21.18	....	......	32.14	.47
Shakopee (upper bed)...........	45.32	26.13	25.40	12.50	......	8.20		15.02	....	......	38.54	.33
Shakopee (lower bed)...........	46.61	20.53	26.12	9.82	......	11.34		14.42	....	......	38.80	.12
La Salle (upper bed)	90.14	1.86	50.52	.89	......	3.08		4.92	....	......	41.06	.17
La Salle (upper part of lower bed)....	65.34	3.99	36.62	1.91	......	6.86		22.26	....	......	33.28	.50

TABLE 17 —*Detailed chemical analyses of*

County	Sample Number	Location	Operator or owner	Authority
LaSalle[b]............	E 1d	SE. ¼ NW. ¼, sec. 14, T. 33 N. R. 1 E....................	German American Portland Cement Co............	State Geol. Survey........
	E 3	Utica......................	Ill. Hydraulic Cement Co.	....
	E 6a	SE. ¼, sec. 25, T. 33 N., R. 1 E.	Chicago Portland Cement Co..................	State Geol. Survey........
	E 6b	SE. ¼, sec. 25, T. 33 N., R. 1 E.	Chicago Portland Cement Co..................	State Geol. Survey........
LaSalle	L 179	NW. ¼, NW. ¼, sec. 18, T. 33 N., R. 2 E................	Utica Portland Cement Co.	Ill. State Highway Laboratory.................
	L 180	NW. ¼, sec. 6, T. 32 N., R. 2 E.	Bailey Falls Dairy Farm ..	....
LaSalle[r]............	....	....	Chicago Portland Cement Co..................	Eckel: "Cements, Limes, Plasters".............
	....	....	Marquette Portland Cement Co..............	Eckel: "Cements, Lime, Plasters".............
	....	....	German American Portland Cement Co............	Eckel: "Cements, Limes, Plasters"..............
	....	....	German American Portland Cement Co............	Eckel: "Cements, Limes, Plasters".............
	....	....	German American Portland Cement Co............	Eckel: "Cements, Limes, Plasters".............
	....	....	German American Portland Cement Co............	Eckel: "Cements, Limes, Plasters".............
	....	NW. ¼, sec. 11, T. 33 N., R. 1 E	....	Ill. State Geol. Survey....
	....	SE. ¼, sec. 34, T. 34 N., R. 1 E.	....	Ill. State Geol. Survey....
	....	....	Ill. Hydraulic Cement Mfg. Co..................	C. B. Lihme, Analyst.....
	....	....	Ill. Hydraulic Cement Mfg. Co..................	C. B. Lihme, Analyst.....
	....	....	Ill. Hydraulic Cement Mfg. Co..................	C. B. Lihme, Analyst.....
	....	....	Ill. Hydraulic Cement Mfg. Co..................	Eckel: "Cements, Limes, Plasters".............
	....	....	Ill. Hydraulic Cement Mfg. Co..................	Eckel: "Cements, Limes, Plasters".............

Illinois limestones and dolomites—Continued

Geologic formation	$CaCO_3$	$MgCO_3$	CaO	MgO	CO_2	Fe_2O_3	Al_2O_3	SiO_2	Other mineral constituents	Volatile matter	Loss on ignition	H_2O at 105°C
La Salle (lower part of lower bed)....	65.38	5.06	36.64	2.42	......	9.56		17.76	....	......	34.36	.57
Lower Magnesian..	50.60	38.25	28.36	18.30	......	3.72		4.58	....	......	44.92	.11
La Salle (upper bed)	91.57	1.23	51.32	.59	......	2.86		4.32	....	......	41.92	.16
La Salle (lower bed)	82.22	1.55	46.08	.74	......	5.56		9.62	....	......	39.16	.38
Shakopee.........	81.50	11.14	......	......	......	3.36		3.76	....	......	......	......
La Salle..........	89.71	1.13	......	......	......	4.44		4.14	....	......	......	......
La Salle..........	......	......	49.46	.91	......	3.92		6.06	Volatile matter, 39.06.....	......	......	......
La Salle..........	......	......	49.37	.85	......	1.30		8.20	Volatile matter, 39.72.........	......	......	......
La Salle..........	......	......	45.57	4.36	......	3.43		7.54	Volatile matter, 39.57.........	......	......	......
La Salle..........	......	......	48.29	3.66	......	2.52		5.06	Volatile matter, 41.05.........	......	......	......
La Salle..........	......	......	45.91	1.00	......	2.61		13.89	Volatile matter, 36.82.........	......	......	......
La Salle..........	......	......	52.02	1.11	......	1.43		5.43	Volatile matter, 40.24.........	......	......	......
La Salle..........	......	......	47.84	.66	......	5.92		6.72	Volatile matter, 40.20.........	......	......	......
La Salle..........	......	......	43.46	1.16	......	7.84		11.10	Volatile matter, 37.38.........	......	......	......
Shakopee.........	......	......	30.17	20.69	......	1.52	3.36	29.84	Volatile matter, 10.24.........	......	......	......
Shakopee.........	......	......	29.94	20.01	......	1.41	2.33	27.70	Volatile matter, 16.03.........	......	......	......
Shakopee.........	......	......	30.30	20.81	......	1.36	3.39	26.46	Volatile matter, 13.38.........	......	......	......
Shakopee.........	......	......	29.51	20.38	......	1.35	11.61	11.89	....	......	......	......
Shakopee.........	......	......	33.04	17.26	......	.80	10.60	27.60	....	......	......	......

TABLE 17.—*Detailed chemical analyses of*

County	Sample Number	Location	Operator or owner	Authority
La Salle[g]	....	Bailey's Falls	....	Ill. State Geol. Survey
	....	Bailey's Falls	....	Ill. State Geol. Survey
	....	Sec. 14, T. 33 N., R. 1 E.	....	Ill. State Geol. Survey
	....	Sec. 14, T. 33 N., R. 1 E.	....	Ill. State Geol. Survey
	....	Sec. 14, T. 33, N., R. 1 E.	....	Ill. State Geol. Survey
La Salle[p]*	....	Utica	....	Blaney & Mariner
La Salle[q]	....	....	....	....
	....	....	....	....
	....	....	....	....
Lee[b]	C 5a	SW. ¼, sec. 27, T. 22 N., R. 9 E.	Sandusky Cement Co., Dixon	....
	C 5b	SW. ¼, sec. 27, T. 22 N., R. 9 E.	Sandusky Cement Co., Dixon	....
	C 6	NE. ¼, sec. 18, T. 22 N., R. 9 E.	Sandusky Cement Co., Dixon	....
	S 46c	Sec. 27, T. 22 N., R. 9 E.	Sandusky Cement Co., Dixon	....
	S 46d	Sec. 27, T. 22 N., R. 9 E.	Sandusky Cement Co., Dixon	....
	S 46e	Sec. 27, T. 22 N., R. 9 E.	Sandusky Cement Co., Dixon	....
	L 188	SE. ¼, SW. ¼, sec. 21, T. 22 N., R. 9 E.	State of Ill. Hospital for the Insane	Ill. State Highway Laboratory
Logan[b]	E 28a	Near NW. cor. sec. 5, T. 19 N., R. 3 W.	....	....
	E 28b	Near NW. Cor. sec. 5, T. 19 N., R. 3 W.	....	....
Madison[a]	....	Alton	Alton Lime & Cement Co.	H. E. Tuttle, St. Louis, Mo.
	....	Alton (top layer)	Harry Gissal Quarry Co.	R. W. Erwin, Granite City, Ill.
	....	Alton (No. 1)	Harry Gissal Quarry Co.	R. W. Erwin, Granite City Ill.
	....	Alton (No. 2)	Harry Gissal Quarry Co.	R. W. Erwin, Granite City Ill.
	....	Alton (No. 5)	Harry Gissal Quarry Co.	R. W. Erwin, Granite City, Ill.
	....	Alton (north layer)	Harry Gissal Quarry Co.	R. W. Erwin, Granite City, Ill.
	....	Alton (south layer)	Harry Gissal Quarry Co.	R. W. Erwin, Granite City, Ill.
	....	Alton (building stone)	Harry Gissal Quarry Co.	R. W. Erwin, Granite City, Ill.
	....	Alton	Reliance Quarry & Construction Co.	E. L. Ohnsorg

Illinois limestones and dolomites—Continued

Geologic formation	$CaCO_3$	$MgCO_3$	CaO	MgO	CO_2	Fe_2O_3	Al_2O_3	SiO_2	Other mineral constituents	Volatile matter	Loss on ignition	H_2O at 105°C
La Salle (upper bed)	......	......	52.32	.58	......	1.96		2.66	Volatile matter, 38.54.........	......	......	......
La Salle (lower bed)	......	......	41.54	1.14	......	7.58		15.24	Volatile matter, 38.80.	......	......	......
La Salle (upper bed)	......	......	51.78	.69	......	2.24		2.88	Volatile matter, 42.06.........	......	......	......
La Salle (upper part of lower bed)....	......	......	46.08	1.96	......	4.76		8.78	Volatile matter, 39.26.........	......	......	......
La Salle (lower part of lower bed)....	......	......	45.58	1.38	......	4.40		10.34	Volatile matter 37.88.........	......	......	......
Shakopee.........	43.50	30.07	......	......	......	....		......	Clay, 20.00; Free silica, 1.00; Iron carbonate, 2.00; Potash, 0.18.....	......	3.00	......
La Salle..........	......	......	44.44	1.12	......	1.97		17.11	....	......	......	......
....	......	......	42.03	1.54	......	3.91		18.54	....	......	......	......
....	......	......	41.75	1.21	......	3.71		19.49	....	......	......	......
Platteville........	88.54	1.42	49.62	.68	......	3.66		5.52	....	......	40.68	.20
Platteville........	87.29	4.14	48.92	1.98	......	3.88		3.44	....	......	41.70	.16
Platteville........	65.98	23.45	36.98	11.22	......	4.60		4.50	....	......	43.72	.11
Platteville........	86.50	1.25	48.48	.60	......	3.54		7.56	....	......	40.54	.09
Platteville........	81.79	9.57	45.84	4.58	......	2.58		5.10	....	......	41.94	.25
Platteville........	83.93	5.02	47.04	2.40	......	4.44		4.78	....	......	41.92	.14
Platteville........	56.60	42.18	......	......	......	2.10		0.84	....	......	......	......
McLeansboro.....	90.28	1.71	50.60	.82	......	2.66		4.70	....	......	41.86	.11
McLeansboro.....	83.79	8.95	46.96	4.28	......	4.92		2.04	....	......	42.84	.16
St. Louis (?)......	97.53	.44	......	......	......	.16		.48	....	......	......	1.48
St. Louis.........	98.20	Trace	......	......	......	Trace	......	.30	....	......	......	......
St Louis.........	92.35	1.00	......	......	......	Trace	......	6.52	....	......	......	......
St. Louis.........	95. 8	.75	......	......	......	Trace	......	2.41	....	......	......	......
St. Louis.........	97.30	.21	......	......	......	Trace	......	1.00	....	......	......	......
St. Louis.........	97.81	1.35	......	......	......	Trace	......	1.00	....	......	......	......
St. Louis.........	98.09	.94	......	......	......	Trace	......	.50	....	......	......	......
St. Louis.........	95.53	.14	......	......	......	.16	......	.48	....	......	......	0.14
St. Louis.........	95.79	.38	......	......	......	.41	1.41	2.01	....	......	......	......

TABLE 17.—*Detailed chemical analyses of*

County	Sample Number	Location	Operator or owner	Authority
	....	Alton	Reliance Quarry & Construction Co.	
Madison[s]	....	Alton	J. Armstrong	S. E. Swartz
Marshall[b]	E 20b	SW. ¼, NW. ¼, sec. 14, T. 12 N., R. 9 E.		
	E 23	SE. ¼, sec. 14, T. 12 N., R. 9 E.		
Monroe	L 66	S. ½, sec. 17, T. 1 S., R. 10 W.		
	L 67	W. ½, sec. 21, T. 3 S., R. 8 W.		
	L 68	SW. ¼, sec. 3, T. 3 S., R. 7 W.	Columbia Quarry Co., Valmeyer, Ill.	
	L 69	Cen. N. line, NE. ¼, sec. 18, T. 2 S., R. 10 W.	Mr. Wessel, New Hanover,	
	L 70	NW. ¼, SE. ¼, sec. 15, T. 3 S., R. 7 E.		
Monroe[a]	....	Millstadt	Columbia Quarry Co.	
Montgomery[b]	694	Hillsboro	Josiah Bixler	
	698	Hillsboro	Josiah Bixler	
Montgomery	L 425	Litchfield	Kiggins Crushed Stone Co.	
Ogle[b]	C 7a	SE. ¼, sec. 27, T. 23 N., R. 9 E.		
	C 8	NW. ¼, sec. 28, T. 24 N., R. 10 E.		
Ogle	L 190	NW. ¼, NW. ¼, sec. 8, T. 22 N. R. 9 E.	Herman Hughes, Dixon Ill.	
	....	....	....	....
Peoria[b]	Bu 8	SE. ¼, sec. 5, T. 11 N., R. 7 E.	Fred Streitmatter, Princeville	
	Bu 9	SE. cor. sec. 10, T. 8 N., R. 7 E.	George Swords, Maxwell	
	E 24a	SE. ¼, sec. 10, T. 8 N., R. 7 E.	George Swords	
	E 24b	SE. ¼, sec. 10, T. 8 N., R. 7 E.	George Swords	
	E 24c	SE. ¼, sec. 10, T. 8 N., R. 7 E.	George Swords	
	E 26	SE. ¼, sec. 5, T. 11 N., R. 7 E.		
Pike[h]	....	Above village of Kinderhook	Mr. Churchill	Henry Pratten
Pike[i]	....	Well's quarry near mouth of Six Mile Ck.		Henry Pratten
Pulaski[b]	D 47	Sec. 14, T. 14 S., R. 1 W.		F. W. Pate
Pope[b]	D 48	NE. ¼, sec. 31, T. 13 S., R. 5 E.	Whittenberg Farm	
	W 311	Sec. 31, T. 13 S., R. 5 E.		
	W 319	Sec. 19, T. 13 S., R. 7 E.		
	W 320	SW. ¼, SE. ¼, sec. 22, T. 11 S., R. 7 E.		
	W 321	Sec. 26, T. 13 S., R. 6 E.		
	Bu 20	Sec. 26, T. 13 S., R. 6 E.		
		Golconda		
	....	....	....	....
	....	....	....	....
Randolph[p]	B 2	Menard	Southern Ill. Penitentiary	
	B 4	Menard	Southern Ill. Penitentiary	

Illinois limestones and dolomites—Continued

Geologic formation	$CaCO_3$	$MgCO_3$	CaO	MgO	CO_2	Fe_2O_3	Al_2O_3	SiO_2	Other mineral constituents	Volatile matter	Loss on ignition	H_2O at 105°C
St. Louis.........	......	......	53.11	2.00	43.30	.68		.30	....	......	......	......
St. Louis.........	97.72	......	......	......	......	.20	1.10	1.01	....	......	......	......
McLeansboro.....	55.78	1.84	31:26	.88	......	8.92		31.74	....	......	27.74	.65
McLeansboro.....	92.36	1.50	51.76	.72	......	2.36		3.42	....	......	41.38	.22
Ste. Genevieve....	91.60	2.51	......	......	......	1.28		4.33	....	......	......	......
Okaw limestone....	95.70	2.50	......	......	......	0.85		0.81	....	......	......	......
Kimmswick.......	95.70	3.46	......	......	......	0.74		0.08	....	......	......	......
St. Louis.........	92.50	2.97	......	......	......	2.74		1.32	....	......	......	......
Salem...........	95.20	2.56	......	......	......	0.62		1.30	....	......	......	......
....	98.43	......	......	.01	......	.44		1.12	....	......	......	......
McLeansboro.....	94.84	1.78	53.15	.85	......	2.29		1.41	....	......	42.98	.13
McLeansboro.....	93.53	2.15	52.42	1.03	......	3.45		2.06	....	......	42.26	.16
Shoal Creek.......	96.40	.76	......	......	......	.43	.28	1.76	FeS,. 30.........	......	......	......
Platteville........	86.36	11.41	48.40	5.4	......	1.56		1.38	....	......	43.98	.19
Platteville........	51.25	34.32	28.72	16.42	......	4.22		5.62	....	......	43.90	.33
Platteville........	76.36	19.16	......	......	......	2.30		3.10	....	......	......	......
Galena..........	44.67	31.00	......	......	......	4.00		21.20	....	......	......	......
Maxwell (probably Lonsdale........	83.40	.88	46.74	.42	......	3.24		13.36	....	......	37.94	.14
Maxwell (probably Lonsdale).......	80.93	.96	45.30	.46	......	3.98		14.24	....	......	36.70	.23
Maxwell (probably Lonsdale).......	70.05	1.00	39.26	.48	......	5.88		21.96	....	......	32.88	.48
Maxwell (probably Lonsdale).......	73.83	1.17	41.38	.56	......	3.70		21.04	....	......	33.70	.25
Maxwell (probably Lonsdale).......	91.93	3.89	51.52	1.86	......	1.82		2.78	....	......	42.70	.12
Pennsylvan'n (probably Lonsdale)...	78.83	1.05	44.18	.50	......	3.30		16.46	....	......	35.92	.26
Upper Kinderhook.	68.15	18.55	......	......	......	0.77	0.77	7.00	MnO, 2.11......	......	......	2.82
Niagaran.........	61.60	33.14	......	......	......	1.60		......	Insoluble matter, 3.35..........	......	......	.31
St. Louis.........	92.70	2.26	51.95	1.08	......	.49		6.38	....	......	......	.07
Chester..........	87.32	2.65	48.88	1.28	......	1.14		10.45	....	......	......	......
Chester..........	78.72	2.47	49.16	1.18	......	2.74		7.90	....	......	40.08	.27
Chester..........	86.43	3.34	48.44	1.60	......	2.36		7.04	....	......	40.46	.42
Ste. Genevieve....	70.52	1.76	39.52	.84	......	8.86		18.06	....	......	33.72	.73
Chester..........	89.82	2.09	50.34	1.00	......	2.90		5.44	....	......	40.92	.11
Chester..........	88.75	3.68	49.74	.93	......	2.02		7.66	....	......	39.85	.21
Golconda........	91.52	2.26	51.42	1.08	......	1.92		6.32	....	......	39.42	.19
....	87.18	2.70	48.98	1.29	......	3.72		8.90	....	......	37.97	.43
....	91.67	4.07	51.50	1.95	......	2.84		4.76	....	......	38.65	.27
Chester (Okaw?)..	77.12	......	......	......	......	5.82		......	Insoluble, 8.98..	......	......	......
Chester (Okaw?)...	61.09	......	......	......	......	2.72		......	Insoluble, 33.98.. Phosphorus, .05..	......	......	......

TABLE 17.—*Detailed chemical analyses of*

County	Sample Number	Location	Operator or owner	Authority
Randolph[b]	B 6	Sec. 23, T. 7 S., R. 7 W.		F. W. Pate
	B 8	Sec. 23, T. 7 S., R. 7 W.		F. W. Pate
	U 47	Sec. 20, T. 5 S., R. : W.	F. M. Brickley	
	W 208	NW. ¼, sec. 15, T. 7 S., R. 7 W.		
	W 209	NW. ¼, sec. 15, T. 7 S., R. 7 W.		
	W 253	SW. ¼, sec. 5, T. 4 S., R. 8 W.	Red Bud city quarry	
	W 254	NW. ¼, sec. 4, T. 4 S., R. 8 W.	William's quarry, Red Bud	
Randolph	K 8	NE. ¼, NW. ¼, sec. 23, T. 7 S., R. 7 W.	Penitentiary at Chester	
	K 9	¼mi. N. of Prairie du Rocher		
	K 12A	Cen. NW. ¼, sec. 30, T. 7 S., R. 7 W.		
	K 13A	Cen. NW. ¼, sec. 30, T. 7 S., R .6 W.		
	K 13B	Cen. NW. ¼, sec. 30, T. 7 S., R. 6 W.		
	K 13C	Cen. NW. ¼, sec. 30, T. 7 S., R. 6 W.		
	K 13D	Cen. NW. ¼, sec. 30, T. 7 S., R. 6 W.		
	K 17B	Near Cen. sec. 33, T. 7 S., R. 6 W.		
	K 22	Cen. SE. ¼, sec. 24, T. 38 N., R. 8 W.		
	K 23	NW. ¼, sec. 12, T. 6 S., R. 8 W.		
	K 24A	SW. ¼, sec. 4, T. 6 S., R. 8 W.		
	K 26	At nose of hill about ¼ mi. NE. Prairie du Rocher		
Randolph[p]	B 9	Menard	Southern Ill. Penitentiary.	F. W. Pate
Rock Island[b]	Bu 15	Sec. 25, T. 17 N., R. 1 W.		
	Bu 16	Sec. 25, T. 17 N., R. 1 W.		
Rock Island[a]		Moline	Cady Stone Co.	
		Moline	Cady Stone Co.	
		Moline	Moline Stone Co.	F. A. Genth, Philadelphia, Pa.
Sangamon[n]		State House quarry on Sugar Ck		Henry Pratten
Schuyler[b]	C 30	SE. ¼, sec. 29, T. 1 N., R. 2 W.		
	C 31	NW. cor. sec. 19, T. 1 N., R. 2 W		
	C 32	NW. ¼, sec. 7, T. 1 N., R. 2 W.		
	C 34	SW. cor. sec. 34, T. 2 N., R. 3 W.		
	C 35a	NW. ¼, sec. 17, T. 2 N., R. 3 W.		
	C 35[b]	NW. ¼, sec. 17, T. 2 N., R. 3 W.		
	C 36	NW. ¼, sec. 11, T. 2 N., R. 3 W.		
	C 37	SW. ¼, sec. 27, T. 3 N., R. 3 W.		
	C 43	Near cen. NE. ¼, ces. 28, T. 2 N R. 2 W.		

Illinois limestones and dolomites—Continued

Geologic formation	$CaCO_3$	$MgCO_3$	CaO	MgO	CO_2	Fe_2O_3	Al_2O_3	SiO_2	Other mineral constituents	Volatile matter	Loss on ignition	H_2O at 105°C
Chester (Okaw)	93.73	3.84	52.53	1.84	......	1.11		2.47	......	......	......	.11
Chester (Okaw)	95.54	3.22	53.54	1.54	......	.67		1.89	......	......	......	.07
St. Louis	97.85	1.38	54.84	.66	......	.56		.58	......	......	43.98	.28
Menard	95.37	1.44	53.45	.69	......	1.28		1.85	......	......	43.08	.22
Chester	86.13	1.42	48.27	.68	......	1.94		9.62	......	......	39.00	.16
Chester (probably Okaw)	81.76	7.61	45.82	3.64	......	5.12		4.54	......	......	41.26	.69
Chester (probably Okaw)	96.42	1.09	54.04	.52	......	2.00		1.50	......	......	42.72	.13
Okaw	93.45	1.86	......	......	......	1.00		3.62	......	......	......	......
St. Louis	97.73	1.37	......	......	......	0.38		0.50	......	......	......	......
St. Louis	86.05	9.00	......	......	......	3.07		1.74	......	......	......	......
Okaw	94.98	2.12	......	......	......	1.20		1.52	......	......	......	......
Menard	93.27	2.98	......	......	......	2.84		1.04	......	......	......	......
Menard	91.23	2.71	......	......	......	2.10		3.77	......	......	......	......
Menard	95.09	2.38	......	......	......	1.16		1.42	......	......	......	......
Menard	90.44	2.38	......	......	......	1.26		6.06	......	......	......	......
Okaw	94.48	2.48	......	......	......	1.43		1.75	......	......	......	......
Okaw	87.66	5.00	......	......	......	2.78		4.52	......	......	......	......
Okaw	84.95	2.48	......	......	......	1.54		10.84	......	......	......	......
St. Louis	95.89	2.12	......	......	......	10.6		0.90	......	......	......	......
Okaw	89.40	3.07	......	......	......	1.40		......	Insoluble, 4.92; Phosphorus, 0.05	......	......	......
Hamilton	82.04	5.52	45.98	2.64	......	4.32		6.98	......	......	40.00	......
Hamilton	96.67	1.21	54.18	.58	......	1.16		1.66	......	......	43.38	......
Hamilton	79.34	1.93	......	......	......	7.43		11.00	......	......	......	......
Hamilton	98.04	.44	......	......	......	.66		1.46	......	......	......	......
Hamilton	......	......	54.44	.06	42.02	3.48	......	.65	P_2O_5, 0.083; SO_3, 1.806; organic matter, trace	......	......	.56
McLeansboro	68.73	5.07	......	......	......	......	.70	......	Insoluble matter, 10.27; Iron carbonate, 14.62	......	......	.61
St. Louis	92.53	1.38	51.86	.66	......	1.88		4.14	......	......	41.46	.22
St. Louis	82.90	1.00	46.46	.48	......	3.84		11.88	......	......	37.76	.24
Salem or St. Louis	75.76	2.80	42.46	1.34	......	6.44		15.04	......	......	35.66	.18
St. Louis	88.68	4.68	49.70	2.24	......	3.08		4.14	......	......	42.04	.14
Keokuk	85.61	.88	47.98	.42	......	4.54		9.30	......	......	38.84	.49
Keokuk	64.23	14.30	36.00	6.84	......	5.88		15.80	......	......	36.92	.30
Salem or St. Louis	77.11	5.68	43.22	2.72	......	6.16		11.30	......	......	38.06	.25
St. Louis	90.29	.88	50.60	.42	......	2.70		6.58	......	......	40.66	.24
Pennsylvanian	70.19	3.59	39.34	1.72	......	7.24		18.62	......	......	33.82	.26

TABLE 17.—*Detailed chemical analyses of*

County	Sample Number	Location	Operator or owner	Authority
Schuyler[b]	C 45	NW. ¼, NE. ¼, sec. 5, T. 1 N., R. 1 E.		
	C 46	NW. ¼, SW. ¼, sec. 32, T. 2 N., R. 1 E.		
Stark[b]	E 27a	SW. ¼, SE. ¼, sec. 21, T. 14 N., R. 7 E.		
	E 27b	SW. ¼, SE. ¼, sec. 21, T. 14 N., R. 7 E.		
St. Clair[b]	U 49a	NW. ¼, NE. ¼, sec. 23, T. 1 S., R. 10 W.		
St. Clair[a]		Columbia	Columbia Quarry Co.	Pittsburgh Reduction Co. Pittsburgh, Pa.
Stephenson	C 1a	NW. ¼, SE. ¼, sec. 22, T. 29 N. R. 6 E.	Winslow City quarry	
	C 1b	Sec. 22, T. 29 N., R. 6 E.	Quarry 1 mi. N. of Winslow	
	C 1c	Sec. 22, T. 29 N., R. 6 E.	Quarry 1 mi. N. of Winslow	
	C 1d	Sec. 22, T. 29 N., R. E.	Quarry 1 mi. N. of Winslow	
	C 1e	Sec. 22, T. 29 N., R. 6 E.	Quarry 1 mi. N. of Winslow	
Union[b]	D 2	SE. ¼, sec. 17, T. 12 S., R. 1 W.	Union Stone & Lime Co., Anna	
	U 66	Sec. 17, T. 12 S., R. 1 W.	Union Stone & Lime Co., Anna	
	W 285	NE. ¼, SE. ¼, sec. 1, T. 13 S., R. 2 W.		
Union[a]		Anna	Fruit Growers Refining & Power Co.	R. W. Hunt & Co., Chicago
Union[p]	D 2	Anna	Swan Creek Phosphate Co.	F. W. Pate
	D 8	2 mi. S. of Cobden		
Will	L 111A	SE. ¼, SE. ¼, sec. 17, T. 35 N., R. 10 E.	Markgraf Stone Co, Joliet.	Ill. State Highway Laboratory
	L 111B	SE. ¼, SE. ¼, sec. 17, T. 35 N., R. 10 E.	Markgraf Stone Co., Joliet	Ill. State Highway Laboratory
	L 111C	SE. ¼, SE. ¼, sec. 17, T. 35 N., R. 10.E	Markgraf Stone Co., Joliet	Ill. State Highway Laboratory
	L 112	SW. ¼, SE. ¼, sec. 20, T. 35 N., R. 10 E.	Lincoln Crushed Stone Co., Joliet	Ill. State Highway Laboratory
	L 113	NE. ¼, SE. ¼, sec. 21, T. 35 N., R. 10 E.	National Stone Co., Joliet.	
	L 117B	Cen. N. line NE. ¼, sec. 31, T. 33 N., R. 10 E.	Mr. Barr, Wilmington, Ill.	Ill. State Highway Laboratory
	L 122	SE. ¼, NE. ¼, sec. 14, T. 34 N., R. 10 E.	Mr. McFarland, Elma, Ill.	Ill. State Highway Laboratory
	L 125	SE. ¼, SE. ¼, sec. 20, T. 33 N., R. 11 E.		Ill. State Highway Laboratory
	L 126B	NE. ¼, SW. ¼, sec. 26, T. 32 N. R. 10 E.		Ill. State Highway Laboratory

Illinois limestones and dolomites—Continued

Geologic formation	$CaCO_3$	$MgCO_3$	CaO	MgO	CO_2	Fe_2O_3	Al_2O_3	SiO_2	Other mineral constituents	Volatile matter	Loss on ignition	H_2O at 105°C
Pennsylvanian.....	95.32	.92	53.42	.44	......	2.18		2.66	....	......	42.48	.14
Pennsylvanian.....	94.78	.92	53.12	.44	......	2.14		3.10	....	......	42.22	.24
McLeansboro......	62.95	2.05	35.28	.98	......	7.58		27.24	....	......	29.66	.78
McLeansboro......	79.44	1.50	44.52	.72	......	2.80		15.40	....	......	36.38	.29
St. Louis..........	89.79	2.63	50.32	1.26	......	2.24		5.42	....	......	41.16	.34
....	97.30	.48	......	......	......	1.40		.90	....	......	......	......
Platteville........	46.71	33.90	26.18	16.22	......	3.52		14.02	....	......	40.78	.12
Platteville........	54.99	39.05	30.82	18.68	......	1.54		1.68	....	......	47.00	.13
Platteville........	54.60	41.18	30.60	19.70	......	1.70		2.12	....	......	46.44	.11
Platteville........	53.35	38.59	29.90	18.46	......	2.76		3.22	....	......	45.68	.21
Platteville........	44.57	30.14	24.98	14.42	......	7.04		12.56	....	......	40.02	.31
Ste. Genevieve....	91.38	7.82	51.21	3.74	......	.36		1.99	....	......	......	.05
Ste. Genevieve....	95.64	2.13	53.60	1.02	......	.92		1.76	....	......	43.28	.12
Warsaw-Spergen...	92.46	2.97	51.82	1.42	......	1.48		3.30	....	......	42.32	.10
....	......	......	52.15	1.57	43.62	.66		1.98	....	......	......	......
Ste. Genevieve....	91.41	4.40	......	......	......	3.61		......	Insoluble, 1.993..	......	......	......
....	77.87	9.96	......	......	......	....		1.89	Insoluble, 8.56...	......	......	......
Niagaran.........	47.76	39.0	......	......	......	3.90		9.46	....	......	......	......
Niagaran.........	49.81	39.46	......	......	......	3.52		6.57	....	......	......	......
Niagaran.........	53.23	41.45	......	......	......	20.3		3.41	....	......	......	......
Niagaran.........	52.76	42.78	......	......	......	1.74		3.08	....	......	......	......
Niagaran.........	54.67	42.9	......	......	......	......	.12	......	Iron and silica, 1.40; Oxides, .78	......	......	......
Edgewood........	51.20	5.33	......	......	......	1.02		2.62	....	......	......	......
Cincinnatian?.....	91.98	4.36	......	......	......	1.00		2.76	....	......	......	......
Niagaran.........	54.15	39.69	......	......	......	2.70		3.80	....	......	......	......
Niagaran (?)......	76.58	19.86	......	......	......	1.75		2.12	....	......	......	......

TABLE 17.—*Detailed chemical analyses of*

County	Sample Number	Location	Operator or owner	Authority
Will	L 132	NW. ¼, SE. ¼, sec. 25, T. 37 N. R. 10 E.		Ill. State Highway Laboratory
	L 133	SW. ¼, NW. ¼, sec. 26, T. 36 N. R. 10 E.		Ill. State Highway Laboratory
	L 134	SE. ¼, SE. ¼, sec. 27, T. 36 N., R. 10 E.		Ill. State Highway Laboratory
Will[g]		Joliet		Mr. Pratten
		Wilmington	Barr's Quarry, Wilmington, Ill.	J. M. Lindgren
		Wilmington	Wilmington, Ill.	J. M. Lindgren
Winnebago[a]		Rockton	Rockton Lime & Quarry Co	
		Rockton	Rockton Lime & Quarry Co.	E. C. Eckel
		Rockton	Rockton Lime & Quarry Co	E. G. Smith, Beloit College, Wisconsin
		Rockton	Rockton Lime & Quarry Co	E. G. Smith, Beloit College, Wisconsin
		Rockton	Rockton Lime & Quarry Co	E. G. Smith, Beloit College, Wisconsin
		Rockton	Rockton Lime & Quarry Co	E. G. Smith, Beloit College, Wisconsin
		Rockford	Hart & Page	

a U. S. Geological Survey Mineral Resources, Part II, 1911, p 663, 1912.
b Bleininger, A. V., Lines, E. F., and Layman, F. E., Ill. State Geological Survey Bull. 17, p. 97.
c Emley, W. E., U. S. Bureau of Standards, Technologic Paper 16.
d Geologic Folio No. 81 U. S. Geol. Survey.
e Ill. State Geol. Survey Bull. 8, p. 355
f Geol. of Wisconsin, E. T. Sweet, Vol. 2, p. 681, 1877.
g Geol. Survey of Ill. Vol. I, pp. 99, 134.
h Geol. Survey of Ill., Vol. IV, p. 40.
i Geol. Survey of Ill., Vol. I, p. 135.
j Geol. Survey of Ill., Vol. III, p. 117.

Illinois limestones and dolomites—Concluded

Geologic formation	$CaCO_3$	$MgCO_3$	CaO	MgO	CO_2	Fe_2O_3	Al_2O_3	SiOf	Other mineral constituents	Volatile matter	Loss on ignition	H_2O at 105°C
Niagaran.........	46.01	36.15	......	......	......	3.52		14.20	....	......	......	......
Niagaran.........	45.30	31.73	......	......	......	6.79		14.40	....	......	......	......
Niagaran.........	47.44	36.81	......	......	......	3.84		11.66	....	......	......	......
Niagaran (Athens marble).........	41.92	40.51	......	......	......	1.77l	......	......	Insoluble matter, 14.73.........	......	......	1.07
Edgewood........	86.3	4.6	48.32	2.19	38.54	3.51		8.11	....	......	38.54	......
Maquoketa	76.9	9.7	43.05	2.51	36.99	2.38		13.58	....	......	36.99	......
....	51.03	33.31	......	......	......	3.29		3.14	CO_2 and H_2O, 6.28; Fe, 1.25; S, 1.26.........	......	......	......
....	51.33	37.33	......	......	1.93	.79	1.05	6.39	....	......	......	1.01
....	......	......	29.72	21.74	46.42	.44		1.96	....	......	......	......
....	......	......	30.71	21.78	44.90	.46		2.31	....	......	......	......
....	......	......	28.82	20.04	46.77	.56		3.90	....	......	......	......
....	47.77	40.95	......	......	......	1.73		9.08	....	......	......	......
....	53.00	43.00	......	......	......	......	......	2.00	Other ingredients, 2.00.........	......	......	......

k Geological Survey of Ill., Vol. I, p. 108, 1868.
l Geol. Survey of Ill. Vol. III, p. 573.
m Geol. Survey of Ill. Vol. I, p. 148, 1866.
n Geol. Survey of Ill., Vol. I, p. 61.
o Geol. Survey of Ill., Vol. I, p. 374.
p* Geol. Survey of Ill., Vol. I, p. 256.
p Ill. State Geol. Survey Bull. 4, p. 183.
q U. S. Geological Survey Bull. 522, p. 144.
r Ill. State Geol. Survey Bull. 8, p. 133, 1907
s Twentieth Ann. Rept. U. S. Geol. Survey, Pt. 6, p. 378.
u Twentieth Ann. Rept. U. S. Geol. Survey, Part 6, p. 377, 1899.
* Insoluble in acid.

CHAPTER XII.—USES OF LIMESTONE[1]

By J. E. Lamar

Introduction

Not over a half century ago the uses of limestone were few and simple. It was burned for lime and cement, used in the construction of roads, buildings, and as a flux. At the present time its uses are many, and it now ranks among the foremost of non-metallic mineral products. In 1920 the total limestone used for all purposes in the United States was 91,305,600 short tons (fig. 74) and its value was probably over $100,000,000[2]. This represents a value more than that of the lead, zinc, silver, gold or aluminum produced in the United States for the same period of time.

In the following pages the uses of limestone are described briefly with the specifications for each and general recommendations regarding the suitability of the Illinois limestones for the use under discussion. The use of limestone as a road material has been omitted, as it has been discussed in a preceding chapter.

Cements

The general term cement is applied to all natural or artificial bonding materials including hydraulic limes and the various specific types of cement which have the property of forming a mortar that hardens under water. The various types of cement are as follows:

Portland cement
Natural cement
Hydraulic limes
Puzzolan cements

PORTLAND CEMENT

Portland cement is by far the most extensively used and best known of the various kinds of cement. Its uses are varied and numerous, but in general are associated with the manufacture of some form of concrete.

MANUFACTURE OF PORTLAND CEMENT

Essentially, Portland cement is a mixture of lime-alumina and lime-silica compounds, artificially produced by heating an intimate mixture of limestone and clay or their equivalents. When ground and wetted this mixture forms a coherent mass.

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[1]In the literature pertaining to limestone and its products, the terms "limestone" and "lime" are commonly used interchangeably for limestone. Thus lime dust and agricultural lime may be used to designate limestone dust and agricultural limestone. To insure clarity and definiteness, the term "lime" in this report is restricted to calcined limestone and "limestone" to the stone as found in nature.

[2]Loughlin, G. F. and Coons, A. T., Stone: U. S. Geol. Survey Mineral Resources, 1920, Pt. II, p. 250, 1923.

In the manufacture of Portland cement finely pulverized limestone and clay, or their equivalents, are fed as a dry powder or as a slurry into the upper end of a rotating, inclined steel cylinder, lined with fire brick and fired by gas, oil, or pulverized coal from the lower end. As the cylinder rotates, the mix moves slowly toward the lower end, and finally emerges

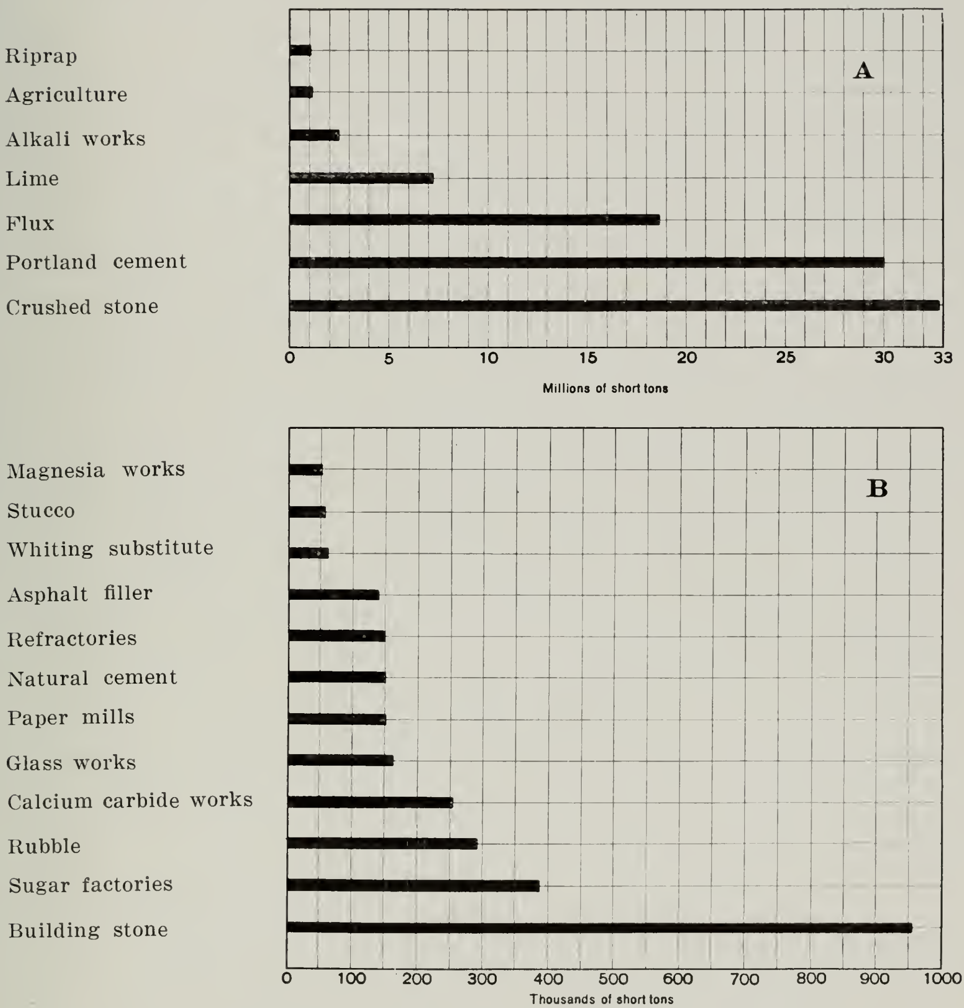

FIG. 70. Graphs showing the 1920 production of limestone in the United States according to the major (A) and minor (B) uses.

at a temperature near its vitrification point as a red hot clinker. The hot clinker is heaped into piles and is allowed to season for a time under the influence of the weather. Subsequently, it is ground to a fine powder with the addition commonly of 2 or 3 per cent of gypsum or some other substance which prevents too quick setting.

CHEMICAL COMPOSITION OF PORTLAND CEMENT

In all probability no two plants operating in separated localities have raw materials identical in chemical composition. It is obvious, therefore, that the chemical composition of their respective cements will vary in like manner. Meade[3] gives the following table showing the permissible variations:

	Per cent
Silica	19-25
Alumina	5-9
Iron oxide	2-4
Lime	60-64
Magnesia	1 4
Sulphur trioxide	1-1.75

At the present time, however, the specifications of the United States Government for Portland cement[4] have increased the permissible amount of magnesia to 5 per cent and the amount of sulphur trioxide to 2 per cent. The permissible amount of iron, if present as the oxide, silicate, or carbonate, is a valuable ingredient as it aids in the formation of the lime-alumina and lime-silica compounds by acting as a flux. Iron, as a sulphide (pyrite) is undesirable because of its sulphur content.

RAW MATERIALS OF PORTLAND CEMENT

The alumina and silica in cement are introduced in the raw state as aluminum silicate, which may be in the form of clay, shale, or slate, if natural products, or as coal ashes or blast furnace slag, if artificial.

The lime content of the cement is derived primarily from limestone. Secondary sources are marble, chalk, marl, oyster shells, and the waste left in the carbonate form in the manufacture of caustic soda from common salt.

EXPLOITATION AND DEVELOPMENT CONSIDERATIONS

In Illinois, limestone or argillaceous limestone and shale or clay, in greater or less quantities, are the materials used in the manufacture of Portland cement. In considering the possible use of any deposit of limestone in the State, therefore, three primary considerations should be taken into account:—namely, the commercial availability of the limestone deposit, the magnesia and silica content of the limestone, and the availability of the necessary clay or shale of satisfactory chemical composition.

The accessibility of a deposit is probably the most important consideration in its commercial availability. A deposit located far from a railroad and overlain by a heavy overburden is not commercially available. Neither is a thin bed of limestone, one about six feet thick covered by 40 feet of overburden, even though it may be near a railroad. However, despite the

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[3]Meade, R. K., Portland Cement, 2d edition, p. 28, 1911.

[4]Bureau of Standards Circular 33, 3rd edition, p. 27, 1917.

fact that a deposit of workable thickness has a heavy overburden, it may be worthy of commercial exploitation by mining, if it is situated on a railroad. In Illinois it is the general, though not extensive practice to mine the limestone where the average overburden exceeds the thickness of the stone to be quarried.

The magnesia content of a limestone is of major importance. As previously stated the maximum permissible amount of magnesia in cement is 5 per cent. It is therefore necessary that the total amount of magnesia in the limestone and clay or shale used to make the cement should not exceed 3 or 4 per cent. This factor of magnesia content is the handicap which prevents the use of the dolomitic limestones of northern Illinois for cement manufacture.

Sand and chert, except in very small amounts, are undesirable in a cement mix, whether they come from the limestone or clay, because they are difficult to grind fine. Unless in this condition a rise in the fusion point of the cement mix is effected, thereby necessitating more intense heating in order to form the desired clinker.

The clay or shale added to the limestone to give the desired mix should be obtained preferably from the overburden removed in quarrying the limestone, but may be secured from the formation underlying the limestone or be brought to the plant from a nearby deposit. The clay or shale should have a low magnesia content in order that the quantity of magnesia contained in the finished cement is less than 5 per cent. It is the high magnesia content of many of the Illinois shales and clays that prevents their use for cement manufacturing purposes.

Practically any Illinois limestone which does not contain an excess of magnesia, chert, pyrite or sand is suitable for cement manufacture and the same may be said for most of the clays and shales. Future development is to be looked for in deposits combining the desirable limestone and shale at the same location.

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NATURAL CEMENT

The raw material from which natural cement is produced is an impure limestone containing from 10 to 22 per cent silica, and 4 to 16 per cent alumina and iron oxide.[5] Many cement rocks carry a considerable percentage of magnesium carbonate which, for natural cement unlike Portland cement, has no harmful effects and may be considered as practically the equivalent of a similar per cent of calcium carbonate.

The process of manufacture of natural cement consists of burning the fragments of stone as they come from the quarry to a temperature slightly above that required in making lime from limestone after which the burned limestone is cooled and finally pulverized.

In order to be a commercially available deposit of natural cement rock it should be located on a railroad and near a good market and coal supply. The limestone exposed in the quarry should have a fairly constant chemical composition both laterally and vertically and should be so situated as to permit cheap quarrying or mining.

In Illinois, the Shakopee dolomite in the bluff along Illinois River east of LaSalle, has been used extensively for the manufacture of natural cements. Elsewhere in the State, the argillaceous members of various limestone formations particularly the basal Salem limestone have been the sources of cement rock for the manufacture of locally consumed cement.

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See also references 1, 5, 7, 9, 10 and 11 under Portland cement.

[5]Eckel, E. C., Cements, limes and plasters, p. 200, 1905.

HYDRAULIC LIMES

Hydraulic limes are those cementing materials which contain sufficient calcium silicate, aluminate or ferrate, to give them the property of setting or hardening under water and also sufficient lime (CaO) so that the clinker after burning will slake upon the addition of water. They are manufactured by burning siliceous or argillaceous limestones containing from 11 to 17 per cent silica and 70 to 80 per cent calcium carbonate. The actual mechanics of burning is very similar to that of ordinary lime. The resulting product commonly contains between 18 and 25 per cent of silica and alumina with or without magnesia or iron oxide.

Modified forms of hydraulic lime are on the market as Grappier cements, and Selenitic lime (Scott's cement). Grappier cements are made by grinding the under- and over-burned lumps residual from the process of slaking hydraulic lime. Selenitic lime is made by adding Plaster of Paris ($CaSO_4$) or sulphuric acid to a hydraulic lime. This treatment is reported to increase the strength of the resulting cement over that of the original lime.

Hydraulic limes are almost entirely a European product and the rather limited consumption in the United States is supplied mainly by imports.

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See also references 1, 7, 9, 10 and 11 under Portland cement.

PUZZOLAN CEMENTS

Puzzolan cements include all types of cement which can be manufactured by the mixing of ingredients without burning. Volcanic ashes of various kinds have been found to be puzzolanic materials, but in the United States, the slag from the limestone used as a flux in blast furnaces, is the chief source of material for this cement. The slag is ground with slaked lime to a fine powder, but is not burned. The addition of water causes the cement to set.

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See also references 1, 7, 9, 10 and 11 under Portland cement.

Limestone as Concrete Aggregate

The most important materials used as aggregate in concrete are crushed limestone and gravel. The former is particularly suited for this purpose because it is composed of fragments of the same sort of material. The fragments are angular and consequently are held firmly by the binding cement, and, because the surfaces of the fragments are rough and unweathered, a close bond between the crystals of the cement and the aggregate is effected.

REQUIREMENTS OF LIMESTONE AS AGGREGATE

The requirements of limestone used as aggregate in concrete roads are specified in the preceding chapter on road materials. Generally, there are no standard specifications made for limestone aggregate for other purposes unless they are made for specific contracts. The stone should, however, be clean and free from dirt, relatively hard, and resist frost and weathering without cracking, scaling, or discoloring. Most quarries producing stone for aggregate also produce stone suitable for road material. As the latter meets all the requirements of a stone for aggregate the product from such quarries is therefore generally of good quality.

SIZES OF LIMESTONE AGGREGATE

Limestone aggregate is produced in a variety of sizes. Some of the most common are ¼-, ½-, ¾-, 1-, 1¼-, 1½-, 2-, 2½-, 3-, 3½-inch. The stone over 2 inches is most commonly used for railroad ballast and bottom courses of roads; the other sizes are used for concrete and various kinds of highway work.

Recently there has been an endeavor to standardize the sizes of crushed stone, and recommendations have been made as follows:[6]

Fine screenings—product of crusher passing ¼-inch laboratory screen.

Chips or dustless screenings—product of crusher passing between ¼- and ¾-inch size.

One-inch stone—product of crusher passing between ¾- and 1¼-inch size.

Two-inch stone—product of crusher passing between 1¼- and 2½-inch size.

Three-inch stone—product of crusher passing between 2½- and 3-inch size. Eighty-five per cent of each size to lie between limits specified.

ILLINOIS LIMESTONES SUITABLE FOR AGGREGATE

Practically all Illinois limestones make suitable aggregate for general concrete purposes, except those which are shaly or occur in thin beds and are therefore likely to split and disintegrate rapidly under the influence of weathering.

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[6]Jackson, F. H., Standard commercial sizes of crushed stone: Pit and Quarry, vol. 4, No. 6, p. 90, March 20, 1920.

Fluxes

Limestone as Blast Furnace Flux in the Iron Industry

A flux is any substance added to a furnace charge which either dissolves or combines with the infusible impurities of the ore to make a fusible product known as slag. The use of limestone as a flux in the blast furnace is an ancient one. Limestone ($CaCO_3$), dolomite ($Ca\ CO_3$, $Mg\ CO_3$), and lime (CaO) have all been used as fluxes, but at the present time the first two are used most extensively. Some lime is still used, but in general it has been proved uneconomical both experimentally[7] and practically.

Some iron ores contain sufficient carbonates to be self fluxing. In general, however, it is necessary to add some flux even to this type of ore. Depending on whether the ore is high or low in carbonate content the flux added is either argillaceous (clay ironstone) or calcareous (limestone).

THE EFFECT OF LIMESTONE FLUX ON IRON ORES

In smelting iron ores with a siliceous gangue, the limestone flux is added at the top of the furnace where it is first converted by the heat of the furnace into lime (CaO). The lime reacts with the siliceous and aluminous materials of the ore to form a double silicate of lime and alumina which contains practically no iron, and which is fusible at the temperature ordinarily employed in blast furnaces.

When iron ores with a practically infusible argillaceous gangue are heated the argillaceous materials combine with the ferrous oxides to produce a fusible double silicate of iron and alumina. As this involves the loss of a certain amount of iron, limestone is added to form a double silicate of lime and alumina resulting in practically complete exclusion of iron from the slag.

CHEMICAL REQUIREMENTS FOR LIMESTONE AND DOLOMITE AS A FLUX

There has been considerable controversy regarding the suitability of dolomite as a flux. The earlier writers condemned it, but at present the status of limestone and dolomite as fluxes is about on a par. The chief distinction between the two is that the magnesia in the dolomite is more difficultly fusible than lime and therefore requires a higher temperature to produce a slag. It has, on the other hand a decided advantage in producing a pig iron of low sulphur content[8], due to its greater affinity for the deleterious sulphur in the furnace charge. The satisfactory use of either limestone or dolomite doubtless depends in a great measure on the character of the ore being smelted.

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[7]Turner, T., The Metallurgy of Iron.

[8]Phillips, W. B., Iron making in Alabama: Geol. Survey of Alabama, p. 116, 1912.

SILICA CONTENT

In order that the flux combine with the siliceous material of the ore, it is desirable that the limestone be as free as possible from silica. Figures on exact limits as to permissible amounts of silica in a flux vary considerably, but in general it is required that the silica should not greatly exceed 5 per cent. Most fluxes in common use contain less than 3 per cent of silica.

CARBONATE CONTENT

In general, the calcareous fluxes in use contain over 90 per cent of either calcium or calcium and magnesium carbonates. Other things being equal, the best fluxes are those with the greatest content of these basic carbonates.

BITUMINOUS OR ORGANIC IMPURITIES

Highly fossiliferous bituminous limestone, or limestones containing much organic material are unsuited for use as fluxes, because the carbonaceous material which they contain usually is in a form which does not permit ready combustion and therefore renders the stone refractory in the blast furnace.

OTHER IMPURITIES

Pyrite, alumina, phosphorus, and earthy impurities should be avoided in fluxing stone because they add to the furnace charge undesirable substances, some of which are not entirely removed with the slag and remain in the iron. Their effect is in general to produce properties in the iron which are undesirable.

PHYSICAL REQUIREMENTS OF LIMESTONE AND DOLOMITE AS FLUX

Flux stone should be screened to remove dirt and fine dust, and washed before shipment if it is particularly dirty, or if an especially high grade product is desired.

The specifications relative to the size of flux stone vary widely according to the rapidity with which the stone decomposes in the furnace. The common requirements are that the stone should pass a 4½-inch ring and be retained on a ½-inch ring. Regarding this matter Sweetser states that, "It is, however, generally conceded that a closer sizing of flux stone is beneficial; and where a 'ballast size' stone has been used there has been some improvement in the working of the furnace".[9]

Limestone as a Basic Open Hearth Furnace Flux

The function of a limestone flux in an open hearth furnace is the same as in a blast furnace, namely to form a slag containing the silica, alumina, phosphorus, and sulphur from the furnace charge. In addition it helps to

[9]Sweetser, R. H., Present day blast-furnace practice: Mining and Metallurgy, No. 183, p. 43, March, 1922.

insure a thorough mixing of the charge. The general requirements as to the chemical and physical composition of the limestone are identical with those for blast furnace flux.

ILLINOIS LIMESTONE SUITABLE FOR BLAST AND OPEN HEARTH FURNACE FLUX

The Pennsylvanian limestone at Fairmount and the Niagaran dolomite are utilized extensively as flux stone. However, any Illinois limestone which is sufficiently pure may be used as a flux. The Kimmswick, parts of the Burlington, Ste. Genevieve, Salem and Okaw limestones, would make good flux stone.

REFERENCES ON LIMESTONE AS A FLUX IN IRON MAKING

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Limestone as a Flux in Copper Smelting[10, 11]

A large per cent of the copper ores under exploitation occurs in a siliceous gangue. It is necessary therefore to add to the furnace charge some basic substance or substances which will form a slag with the silica of the

[10]Peters, E. D., The principles of copper smelting, Hill Publishing Company, p. 120, 1907.

[11]Maynard, T. P., Limestone and cement materials of North Georgia: Geol. Survey of Georgia Bull. 27, pp. 6-8, 1912.

ore and thus render it removable. For this purpose limestone and dolomite are used, although limestone is commonly preferred.

The primary requirements for flux stone for this purpose are that it have a high carbonate content and be free from silica, organic and other impurities. Small amounts of iron are not generally considered harmful.

Limestone in the Metallurgy of Sulphide Lead Ores[12-15]

In the "lime roasting" or "pot roasting" process of desulphurization of sulphide lead ores, limestone, dolomite or lime are mixed with the ore and subjected to a stream of hot air in a reverberatory furnace. Under these conditions oxidization is favored and when once started continues without further addition of heat. Subsequent to the roasting the ore is heated in a converter. The final products are lead oxide, lead silicate, and calcium sulphate.

"Lime roasting" has been largely replaced by "blast roasting" which is essentially roasting by means of a forced draft of hot air. There are several processes of blast roasting, but the Savelsberg process principally involves the use of limestone as a flux. The stone is used in a finely crushed condition and is fed into the converter together with the lead ore.

REQUIREMENTS FOR THE LIMESTONE FLUX

The essential requirement for limestone to be used in the roasting of sulphide lead ores is that it be as pure as possible. As the limestone is converted into lime by the heat of the roasting and reacts with the lead ore as lime, the smaller the impurities in the original stone, the greater is the yield of lime per unit of stone. Siliceous and argillaceous impurities not only decrease the lime yield but also form an unnecessary and undesirable amount of slag. Magnesia raises the formation temperature of the slag:—that is, it requires a higher temperature than lime to form a slag of equal fluidity. As much as 5 per cent of magnesia is said to be permissible in slag, and a like amount is probably permissible in the limestone flux.

SUITABILITY OF ILLINOIS LIMESTONE FOR FLUX

From the table of chemical analyses (Table 17) it will be seen that many of the Illinois limestones are of sufficient purity to be used as a flux in the metallurgy of sulphide lead ores.

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[12] Maynard, T. P., Limestones and cement materials of northern Georgia: Geol. Survey of Georgia Bull. 27, p. 8, 1912.

[13] Ingalls, W. R., Lead and zinc in the United States, Hill Publishing Company, New York, 1908.

[14] Collins, H. F., The metallurgy of lead, Griffin and Company, London, 1910.

[15] Hofman, H. O., The metallurgy of lead, McGraw-Hill Company, New York, 1918.

Lime

Lime may be defined as the product obtained by calcining essentially pure limestone or dolomite and possessing the property of slaking with water. Calcining is essentially the process by which carbon dioxide and water are removed from a limestone or dolomite by heating it to a high temperature. The burned product is calcium oxide or calcium and magnesium oxides.

$CaCO_3$ (limestone) + heat = $CaO + CO_2$

$CaCO_3$, $MgCO_3$ (dolomite) + heat = $CaO + MgO + 2\ CO_2$

The process of calcining, or burning as it is more commonly called, is carried out commercially in kilns of various types, but the most common are the continuous or intermittent vertical kilns, into which the limestone is fed from the top and withdrawn from the bottom. The kilns are fired by coal, oil, or gas in such a manner that the hottest part of the kiln is at the lower end where the calcined limestone is withdrawn.

LIMESTONE BURNED FOR LIME

To the lime manufacturer the word limestone is used "as a general term referring to that class of rocks containing at least 80 per cent of the carbonates of calcium or magnesium, which, when calcined give products that slake upon the addition of water".[16]

Generally the purer the limestone, the better the yield of quicklime under similar burning conditions. The relations of purity and yield as stated by Frasch[17] may be summarized as follows:

Purity of limestone (carbonates) *Per cent*	Yield of burnt lime *Per cent*	Calcium oxide in the burnt lime *Per cent*
95	59	90
90	60	80
85	65.5	72
80	70	64

A comparison of limestone of high and of comparatively low carbonate content shows that the former yields a smaller amount of burnt lime than does the latter, but that the quality of the product measured by the calcium oxide it contains compensates for the difference in quantity.

EFFECTS OF IMPURITIES IN RAW STONE ON LIME OBTAINED

The limestone or dolomites generally burned for lime do not have much less than 97 per cent of combined carbonates of calcium and magnesium. The remaining 3 per cent of the limestone is impurities which are most commonly silica, alumina, iron oxide and iron sulphide. It is recommended, however, that the total impurities in unburned limestone should

[16]Lazell, E. W., Hydrated lime, p. 21, 1915.

[17]Mineral Industries, vol. 7, p. 483.

not exceed 2½ per cent (about 5 per cent in the finished lime) because any in excess of this amount decreases the rapidity of slaking and sand carrying capacity of a lime and makes its working qualities less smooth.

In some limestones, a silica content exceeding 2 per cent has been found to have no detrimental effect on certain limes, but generally the presence of silica even in small amounts has a tendency to "decrease the plasticity, sand carrying capacity and yield of lime, but has no apparent effect on its hardness or strength[18]. More than 10 per cent of silica in a lime is reported to give it hydraulic properties.

Iron oxide and alumina have the same general effects as silica except that the iron oxide colors the lime red or yellow unless it occurs in small amounts. If contained in large amounts, the iron gives the lime additional hardness and strength, but the increase in these properties is usually less desired than the white color which must be sacrificed to gain them.

The presence of a limited amount of alumina in the raw stone is desirable because it increases the hardness and strength of a lime, and also gives it a better color. However, the presence of both silica and alumina produces a sintering on the outside of the limestone lumps if the temperature of the kiln becomes too high in burning. The resultant impervious coating over the outer surface of the lumps prevents the escape of carbon dioxide from the interior, thereby defeating a perfect burn.

Gypsum and iron sulphide even in small amounts are undesirable in a limestone for lime.

Water in a limestone, whether free in the pores or in chemical combination is undesirable, because it necessitates additional heating of the rock for its removal and thereby lowers kiln efficiency.

It seems patent therefore that though lime of good quality can be made from a limestone relatively high in impurities, the undesirable properties imparted by the impurities condemn the lime containing them to a somewhat limited use and field of application, particularly in view of the present extensive use of white lime for interior finishing and as a chemical reagent.

HYDRATED LIME

Hydrated lime is quicklime which has been mechanically slaked with an amount of water not greatly in excess of the quantity necessary to fill the requirements in the following chemical equations:

(High calcium quicklime) $CaO + H_2O \rightarrow Ca(OH)_2$

(Dolomitic quicklime) $CaO + MgO + 2H_2O \rightarrow Ca(OH)_2 + Mg(OH)_2$

The advantage claimed for this type of lime is that it is uniformly slaked under specific chemical control. This obviates hand slaking and produces a smoother and stronger mortar or plaster.

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[18] Emley, W. E., Manufacture of lime: U. S. Bur. of Standards Tech. Paper 16, 1913.

SUITABILITY OF ILLINOIS LIMESTONES FOR LIME

The present lime producing centers of Illinois are Quincy, Alton, and Chicago, where the Burlington limestone, St. Louis limestone, and Niagaran dolomite respectively furnish the raw material for lime manufacture. Elsewhere in the State, particularly where limestones or dolomites outcrop in abundance, the ruins of old lime kilns are a common occurrence. That the limes produced were of good quality is evidenced by the manner in which the plasters made from them have withstood weathering. A study of the chemical analyses (Table 17) shows numerous limestones and dolomites with less than the allowable maximum of 2½ per cent of impurities. In the southern part of the State, many of the Chester formations and also portions of the Ste. Genevieve, St. Louis, Salem, Keokuk-Burlington and Trenton limestones offer stone of a high degree of purity for the manufacture of lime; in the western portion of the State, parts of the St. Louis, Burlington, and Hamilton limestones; and in the northern part, certain phases of the Niagaran, Galena-Trenton, and Platteville dolomites are suitable for lime burning.

THE USES OF LIME

Lime has varied and extensive uses in many different industries and processes. It is a strong base and is therefore used extensively where a strongly caustic substance is desired. Some of the uses of lime are as follows:

- Agriculture
  - As a corrective of acid soil
- Construction
  - Plaster
  - Stucco
- Miscellaneous
  - Acids
  - Alcohol
  - Alkali works
  - Ammonia
  - Barium products
  - Bleaching works
  - Candles
  - Copper works
  - Corn products
  - Cyaniding
  - Disinfectant and deodorizer
  - Dyes
  - Explosives
  - File works
  - Flour mills
  - Gas purification
  - Gas plant by-products
  - Glass works
  - Glue manufacture
  - Gold refining
  - Graphite
  - Greases, butter, etc.
  - Guncotton and gelatine
  - Insecticide
  - Kalsomine
  - Medicines
  - Metallurgy
  - Nitrates and glycerine
  - Paper mills
  - Phenol
  - Platinum refining
  - Polishing and buffing compounds
  - Potash salts
  - Pottery and porcelain
  - Print works
  - Refractories
  - Rubber
  - Salt refining
  - Sand lime brick
  - Sewage and acid waters
  - Sheep dip

THE USES OF LIME—Concluded

Silica brick	Tanneries
Slag cement	Textiles
Soap	Varnish
Sugar refining	Water treatment
Tobacco	Wood distillation

Lime is used in the manufacture of the following chemicals:

Aluminum hydrate	Calcium cyanamide
Acetic acid	Calcium sulphate
Ammonium hydroxide	Calcium chloride
Ammonium sulphate	Calcium carbonate (precipitated)
Bleaching powder	Calcium hydroxide (milk of lime)
Bone ash	Carbon dioxide
Calcium acetate	Potassium dichromate
Calcium carbide	Sodium dichromate

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Agricultural Limestone

Agricultural limestone is finely crushed or pulverized limestone of high carbonate content. The pulverized stone is generally a product especially prepared for agricultural use. The crushed rock, however, that is sold by many of the large quarries for agricultural purposes is commonly the "fines" or screenings which pass a ¼-inch mesh, resultant from the crushing of rock for some other purpose.

EFFECT OF SIZE OF LIMESTONE FRAGMENTS

In order to be an effective agent in the correction of soil deficiencies the limestone used must first dissolve in the water contained in the soil. The rate of solubility of a stone depends on the size of the particles to be dissolved. The finer a given quantity of stone is ground the more surface it exposes to the solvent action of ground water, and the more rapidly it will dissolve. It is obvious that the product passing a ¼-inch screen is a heterogeneous mixture of very fine and relatively large particles of limestone. The finer material being the more rapidly soluble has the greatest immediate results, and in general the immediate results of "liming" will vary with the fineness of stone used. Although some authorities specify that the limestone should pass a 50-mesh sieve, others an 80- and still others a 100-mesh, the fineness of limestone to be used probably depends more on whether the reaction desired from the "liming" is an immediate and marked one, or one which is more gradual and less pronounced, but extended over a longer period of time. For any given purity of limestone, therefore, the finer it is ground the more active, but shorter, is its period of effectiveness.

THE EFFECT OF LIMESTONE ON SOIL

Soil waters in general contain small amounts of carbonic acid, and when limestone is introduced into a soil, this acid reacts with a part of the limestone to form calcium bicarbonate. Since the amount of carbonic acid in the soil at any time is small, the conversion of the limestone to the bicarbonate is not completed at once, but is extended over a period of some time. As a result a soil may contain calcium carbonate (limestone) and calcium bicarbonate from an application of limestone.

EFFECT ON ACID SOILS

Some soils contain organic acids which commonly have accumulated as a result of stagnated drainage. Such soils are known as acid soils. The effect of limestone on such soils is to neutralize the acids present.

EFFECT ON HUMUS

Limestone is said to increase the rate of decomposition of humus. Thus the limestone aids in making the humus materials available for plant consumption. The limestone does not, however, replenish the humus. This must be refurnished to the soil in some other manner by the application of organic fertilizers.

EFFECT ON BACTERIA

The decay of organic soil matter involves certain bacteria which produce ammonia from the nitrogenous portion of the organic material. The soil contains still other bacteria which in their life processes convert this ammonia into nitrates. In this form the nitrogen from the organic material is available to the plants for consumption.

Another type of bacteria are those which obtain nitrogen from the air and fix it in the tubercles of legume roots. In general, experiments have shown that the application of limestone to a soil in quantities up to a certain amount has resulted in an increased number of bacteria of the above types present.

OTHER MINOR EFFECTS

Lime or limestone is said to produce a flocculation of clay particles thereby improving the textures of clays, fine loams, and silts which would otherwise be too sticky or cohesive to be satisfactorily cultivated. It is also said to increase the porosity of heavy soils and the firmness of a light sandy soil.

For some time, it was thought that lime or limestone reacted with minerals in the soil containing potash and made available some of this potash for plants. As a result of recent investigations, however, it has been shown "that the effect of lime and gypsum in bringing into solution potash from the mineral portion of the soil is practically nil."[19]

THE EFFECT OF DOLOMITE ON SOILS

There was at one time, a feeling that the effect of dolomites on soils was inferior to that of limestone. At present, however, these two materials are considered to be on a par. The reaction of dolomite when added to the soil is essentially the same as that of limestone.

AGRICULTURAL LIMESTONE IN ILLINOIS

The accompanying table of chemical analyses (Table 17) of the various limestones and dolomites of Illinois shows a great variety of stone suitable for use as agricultural limestone. A great many of the deposits of these limestones and dolomites are however so located as to be of local value only, being either of too limited extent, or too far from transportation to be available commercially on a large scale. Such deposits are, therefore, of particular interest only in the vicinity in which they are located. They do, however, afford a local supply of agricultural limestone which can often be profitably exploited to save freight and long haulage cost. In the northern part of Illinois particularly, the quarrying of local deposits of limestone and dolomite as sources of agricultural limestone is being actively prosecuted, and it would seem that an adequate statewide appreciation of the real value of agricultural limestone and a development of local deposits is doubtless a thing of the not far distant future.

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[19]U. S. Dept. Ag. Research, Jour. Ag. Research, vol. XIV, p. 297.

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Limestone Ballast

SPECIFICATIONS FOR LIMESTONE BALLAST

Limestone and dolomite are used very extensively for ballast and should fulfill the following specifications for ballast [20, 21], adopted at the March, 1921, meeting of the American Railway Engineering Association in Chicago.

PHYSICAL QUALITIES

General.—Stone for use in the manufacture of ballast shall break into angular fragments which range with fair uniformity between the maximum and minimum size specified herein; it shall test high in weight, hardness, strength and durability, but low in absorption, solubility, and cementing qualities.

Tests.—Tests shall be made as follows:

Weight.—Not less than one-half cubic foot of the stone accurately measured, and dried for not less than twelve hours in dry air at a temperature of between 125 and 140 degrees Fahrenheit shall be weighed. The weight shall be not less than...........lb. per cubic foot.

(Note.—Of the stone available, that having the maximum weight should be used; a high quality stone for ballast will weigh 168 pounds per cubic foot.)

Strength.—Two-inch cubes of the stone shall be sawed to reasonable accurate dimensions and the top and bottom faces made accurately parallel. For primary tests, the test specimens shall be dried for two hours in dry air at a temperature of between 120 and 140 degrees Fahrenheit and at the time of test the temperature of the specimen shall be not less than 50 degrees. Tests shall be made in a testing machine of standard form and the stone shall have a compressive strength of ....lb. per square inch.

(Note.—Of the stone available, that having the maximum compressive strength should be used; a high quality stone for ballast will have a strength of 10,000 pounds per square inch.)

A secondary test shall be made on specimens the same in all respects as for the primary test except that the blocks shall have been completely immersed in clean water, of a temperature between 35 and 90 degrees, for 96 hours, the test to be made within 30 minutes of removal from the water.

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[20] Pit and Quarry, vol. 5, No. 7, p. 60, April, 1921.

[21] Cement, Mill and Quarry, vol. 18, No. 7, p. 31, April 5, 1921.

If the compressive strength shall have decreased more than.........per cent from the primary tests, the rock shall be deemed unsuitable for ballast purposes.

(Note.—Of the stone available, that showing the least difference between the results of the primary and secondary test should be used; a high quality stone for ballast should show not over 1 per cent difference.)

Solubility.—One-fourth cubic foot of the rock shall be crushed and thoroughly washed. The particles shall then be placed in a glass vessel and covered with clear water. The vessel shall be thoroughly shaken for five-minute periods at 12-hour intervals for 48 hours. If any discoloration of the water occurs, the rock shall be deemed soluble and undesirable for use as ballast.

Wear or Durability (Test No. 1).—One-half cubic yard of washed stone, which will pass through the maximum and be retained on the minimum screen, shall be spread over a wire mesh or iron surface to a depth of not more than 3 inches, and exposed to a dry heat of from 125 to 140 degrees Fahrenheit for a period of two hours. After the dried stone is carefully weighed it shall be given 10,000 revolutions in a tumbler approximately four feet in diameter, of not less than two cubic yards capacity, and operating at 25 revolutions per minute.

The sample shall then be passed over a screen of the minimum dimension provided for sizing the ballast, again washed and dried in the same manner as before the test, and again carefully weighed.

If the decrease in weight shall be more than.........per cent of the original weight of the sample, the stone shall be deemed unfit for use as ballast.

Outside of the breakage, which is exhibited by the small particles which will pass through a minimum screen but will not pass a sieve of 20 meshes to the inch, the wear should not exceed.........per cent.

(Note.—Of the stone available, that showing the smallest loss in weight should be used; a high quality stone for ballast will show a loss of not more than 1 per cent in fragments which will pass a screen of 20 meshes to the inch, and not more than 3 per cent in those passing the minimum sizing screen.)

Quick Weathering Test (Test No. 2).—One-half cubic yard of stone shall be dried and weighed as for Test No. 1. It shall then be immersed in water for six hours and then while still wet, be placed in a refrigerating plant and subjected to a temperature of approximately 0 degrees Fahrenheit for two hours. It shall then be removed and the temperature gradually raised in two hours to 100 degrees and that heat continued for two hours, when it shall be immersed as before and again subjected to approximately zero temperature.

The freezing and thawing shall be repeated to a total of ten exposures. If any tendency to disintegrate is observable, the stone should be considered unsuitable for ballast. Otherwise the material shall again be subjected to a wear test as provided under Test No. 1. If in this wear test the maximum decrease in weight shall be in excess of.........per cent, it shall be deemed unsuitable for use as ballast.

(Note.—Of the stone available, that showing the minimum average decrease in weight should be used; a high quality stone for ballast will not show a decrease in fragments which will pass the minimum sizing screen of more than 4 per cent.)

Absorption.—One-half cubic yard of washed stone, which will pass through the maximum and be retained on the minimum screen, shall be spread over a wire mesh or iron surface to a depth of not more than 3 inches, and exposed to a dry heat of from 125 to 140 degrees Fahrenheit for a period of 6 hours. After the dried stone is carefully weighed it shall be submerged in clean water for a period of 96 hours. It shall then be removed from water and exposed to a normal air in the shade and at a temperature between 40 and 80 degrees, and allowed to drip for 30 minutes, when it shall again be weighed and the difference in weight shall be used to determine the rate of absorption. Stone showing an absorption of more than ....lb. per cubic foot is unsuitable for ballast.

(Note.—Of the stone available, that showing the minimum absorption should be used; a high quality stone for ballast will have an absorption of not more than 0.50 pound per cubic foot.

Cementing Quality.—A five-pound sample of the rock thoroughly washed and dried shall be crushed until it will pass through a screen of one-fourth inch mesh. This material shall be placed in a ball mill which contains two steel shot weighing 20 pounds each, and the mill revolved at the rate of 30 revolutions per minute, until it has made 2,000 revolutions for each pound of sample in the mill.

Sufficient clean water shall be added to make a consistent mortar, which shall then be moulded into one-inch cubical briquettes formed under 10-pound pressure. All of the briquettes shall then be allowed to dry 20 hours in air; when one-third of them shall be tested for compressive strength.

One-third shall be kept for four hours in a steam bath, and the remainder shall be immersed for four hours in clean water at a temperature between 50 and 60 degrees Fahrenheit and then tested for compressive strength.

If in any of these tests a compressive strength greater than.........lb. per square inch is developed, the material shall be deemed unsuitable for ballast.

(Note.—Of the stone available, that from which the briquettes show the minimum strength should be used; a high quality stone will show not to exceed 4 pounds per square inch.)

OTHER REQUIREMENTS

Breaking.—Stone for ballast shall be broken into fragments which range with fair uniformity between the size which will in any position pass through a 2½-inch ring and the size which will not pass through a ½-inch ring.

Test for Size (Maximum).—A sample weighing not less than 150 pounds shall be taken from the ballast as loaded in the cars and placed in or on a screen having round holes 2¾ inches in diameter. If a thorough agitation of the screen fails to pass through the screen, 95 per cent of the fragments, as determined by weight, the output from the plant shall be rejected until the fault has been corrected.

Test for Size (Minimum).—A sample weighing not less than 150 pounds shall be taken from the ballast as loaded in the cars; weighed carefully and placed in or on a suitable screen having round holes ½-inch in diameter. The screen shall then be agitated until all fragments which will pass through the screen have been eliminated. The fragments retained in the screen shall then be weighed and if the weight is less than 95 per cent of the original weight of the sample the output of the plant shall be rejected until the fault is corrected.

Handling.—Broken stone for ballast must be delivered from the screens directly to the cars or to clean bins provided for the storage of the output of the crusher. Ballast must be loaded into cars which are in good order and tight enough to prevent leakage and waste of material and are clean and free from sand, dirt, rubbish or any other substance which would foul or damage the ballast material.

ILLINOIS LIMESTONES SUITABLE FOR BALLAST

Table 5 which contains the results of the physical tests on Illinois limestones and dolomites for road material shows numerous stones suitable for ballast. The manner of testing is not identical with that specified above, but the results give a general basis for determining the value of the stone. Illinois is well supplied with stone for ballast, and development of quarries for such a product depends rather on commercial conditions of supply and demand than on the availability of stone.

Riprap and Rubble

Riprap is any stone used for filling in around the base of piers, dams, trestles, abutments, and similar structures to prevent erosion and scour by moving water. For the same purpose it may be placed promiscuously or laid in a revetment along the banks of rivers or canals.

Rubble is any uncut stone of varying size used for rough masonry purposes.

REQUIREMENTS FOR LIMESTONE FOR RIPRAP AND RUBBLE

Limestone is used extensively for riprap and rubble. The specifications which it must meet depend largely on the engineer in charge and the character of the work for which it is to be used. Especially is this true in the case of riprap which may be used in relatively large or small pieces depending on whether the structure which is to be protected, is in rapidly moving or relatively still water. The limestone should, however, be in solid pieces without incipient fractures or clay laminae which may constitute planes of failure later and cause a spawling or breaking of the stone; it should be hard and dense so as to withstand freezing and thawing conditions; and should be fresh and clean especially if it is to be used for rubble.

RIPRAP AND RUBBLE IN ILLINOIS

The demand for riprap and rubble in Illinois is not large and the supply is copious. Practically all of the large Illinois quarries can produce this sort of stone if it is desired. It is also noteworthy that there is a great quantity of stone in the spoil or waste heaps along the Chicago drainage canal. This supply of riprap and rubble has scarcely been touched. Elsewhere in the State there are numerous outcrops close to transportation where riprap and rubble might be secured if the demand warranted quarrying it.

Limestone and Dolomite for Building Stone

Limestone and dolomite have been and still are extensively used for ornamental and building purposes. They have been replaced largely by concrete for some kinds of construction work but are still much used for the erection of public edifices and large buildings. Recently there has been an increased interest in the use of the much stained and weather worn slabs of thin-bedded limestone which have been used very artistically in building and wall construction.

The life of a building stone depends on a number of variable factors. However, under ordinary conditions a coarse-grained, fossiliferous limestone will last from 20 to 40 years before it begins to show notable signs of disintegration or decay. It is obvious also that the position of the stone in the building, the climatic conditions and the chemical content of the atmosphere to which it is subjected may greatly shorten or extend the length of life of the stone.

REQUIREMENTS FOR LIMESTONE AND DOLOMITE BUILDING STONES

The following requirements for and tests made on building stones indicate which are the best stones for a given purpose and set of conditions. However the specifications for stone are so variable that no definite limits can be set.

COLOR

An even color is one of the most desired characteristics of a building stone. It is not necessary that the color of the limestone be white, if only its color, whatever it may be, is uniform and permanent. The permanence of color depends largely on the absence of impurities and the care which is exercised in storing and setting the stone. It has been demonstrated[22] that the staining of building stones is due largely to careless handling, frequent wetting, and to the use of stain-producing cements, mortars, or improperly applied supposedly stain-preventive backings. The most common impurities in limestone which have a discoloring effect are pyrite and marcasite (iron sulphide), sphalerite (zinc sulphide), and clay as seams, reeds or disseminated masses. The sulphides, particularly the iron, when exposed to the atmosphere for a time, are converted to the yellow hydroxide and produce thereby a disagreeable spotting of the stone. Clay seams and reeds offer sites of accumulation for the yellow iron hydroxide from iron bearing water, and may therefore result in disfiguring stains.

HARDNESS

The hardness of limestone for building purposes is commonly determined by an abrasion test, of which a number are in use. Compared with granite, limestone is a soft rock, but varies greatly in the degree of softness with the state of aggregation and the amount and character of impurities. The dense, fine grained stones are generally harder than the coarse porous ones, and those containing siliceous impurities are harder than those containing argillaceous or no impurities.

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[22]McGrath, G. B., Stone staining, its causes and prevention, Stone, Vol. XLII, No. 12, p. 629, December, 1921.

TEXTURE

The texture of a limestone depends on its grain—that is, the coarseness or fineness of the mineral particles comprising the limestone and their disposition with reference to one another. An even-textured limestone is one in which the mineral particles are all roughly of the same size or are of varying sizes homogeneously mixed, while an uneven-textured stone has a variation in the size of particles with some rough sort of segregation. Since good working properties depend greatly upon a uniform or at least persistent texture of a limestone throughout a given bed this is an important factor in judging the suitability of a stone for building purposes.

SPECIFIC GRAVITY

The specific gravity of a limestone is the weight of a unit of dry stone in air as compared with the weight of an equal volume of water. The average specific gravity for 204 samples of Illinois limestone and dolomite is 2.658.

POROSITY AND ABSORPTIVE POWER

Porosity is defined as the percentage of pore space in a stone; absorptive power is the ability of a stone to take up water and is measured by the weight of water which a stone will contain when saturated. The latter is commonly known as the ratio of absorption which is described by Buckley[23] as percentage of the weight of absorbed water to the average weight of the dry sample.

CRUSHING STRENGTH AND TRANSVERSE STRENGTH

Tests for crushing and transverse strength are made to determine the ability of a stone to withstand a load without deformation. The former test is commonly made by subjecting a 2-inch cube of stone to pressure until it breaks. The amount of pressure in pounds per square inch necessary to produce a failure of the stone is the measure of the crushing strength. The transverse strength is the measure of the pressure in pounds per square inch necessary to break a bar of stone one inch in cross section supported ½ inch on both sides of the point where the pressure is applied. The transverse strength is usually expressed as the modulus of rupture which is calculated according to the following formula[24]:

$$\text{Modulus of rupture} = \frac{3 \times \text{weight required to break stone} \times \text{distance between supports}}{2 \times \text{width of the stone} \times (\text{thickness of stone})^2}$$

ABRASIVE STRENGTH

The abrasive strength of a stone is a measure of its resistance to abrasion and is usually determined by subjecting a sample of stone to certain conditions of wear for a specified time.

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[23]Buckley, E. R., Building and ornamental stones of Wisconsin: Wis. Geol. and Nat. Hist. Survey Bull. IV, Econ. Series No. 2, p. 372, 1898.

[24]Ries, H., Building stones and clay products, New York, 1912.

EFFECTS OF TEMPERATURE CHANGES

The effects of temperature changes on a stone are determined by subjecting it repeatedly to alternate freezing and thawing. Some stones may withstand the test and not be markedly damaged. Others, however, are cracked or partially disintegrated. Results similar to those which might be expected in the conflagration of a building are obtained if the sample is subjected to a high temperature.

EFFECTS OF CHEMICAL AGENTS

To determine the effects of the active chemical agents in the atmosphere, samples of stone are subjected to various chemical reagents such as carbonic and sulphurous acid gases and dilute sulphuric acid.

SUMMARY OF REQUIREMENTS

A good stone should possess the following characteristics:

a. Be free from cracks, reeds, and fractures.

b. Have a moderately fine grain and even texture.

c. Be free from deleterious mineral impurities such as pyrite and clay.

d. Be sufficiently hard to stand fairly rough usage but soft enough to work readily.

e. Have a uniform color or variation in color.

f. Have a low porosity and ratio of absorption.

g. Be uniformly fresh throughout.

h. Have a high resistance to abrasion if it is to be used for floor tile, steps, flagging, etc.

i. Have at least a moderately high, crushing strength and modulus of rupture.

j. Withstand well the effects of marked temperature changes and the corrosive effects of the chemical constituents of the atmosphere.

ILLINOIS BUILDING STONES

Before the advent of concrete for general construction work, Illinois was the largest or one of the largest producers of cut stone. In the years 1895 to 1900, the building stone produced in this State was valued at considerably over $1,000,000. In 1910, the value of the stone produced had dropped off to about $100,000, and in 1920, has decreased still further to a little over $15,000. Stone has been quarried for local use at many outcrops throughout the State. The largest quarries, however, were located at and around Chicago, Joliet, Quincy, Kankakee and Grafton. At the present time there are no quarries that make a business of shipping dimension stone. The consumption is local and small. At intervals stone is produced at Joliet, Quincy, Grafton and in Stephenson and Winnebago counties to supply a local demand. The physical properties of Illinois building stone are summarized in Table 18, and absorption tests are given in Table 19.

The Niagaran dolomite was quarried at Joliet and Chicago, and made a good building stone, except that the Joliet stone, known as "Athens marble" colored buff on exposure to the weather. At Quincy, the Burlington limestone was worked and it retained its white color for a long time. At Grafton, the Niagaran dolomite was quarried. It had a decided buff color when fresh and consequently did not discolor much on exposure.

It is obvious from the amount of building stone once produced that Illinois has a copious supply of this material. Illinois, also, is not without deposits of stone of a generally similar nature to the Bedford stone. The Okaw and Burlington limestones, and the oolitic beds of the Ste. Genevieve and Salem, in the southern and western parts of the State would supply a stone of excellent quality should the demand warrant its production.

TABLE 18.—*Table showing certain physical properties of Illinois building stone*[25]

Kinds of stone	Dimensions in inches		No. of Samples	Specific gravity	Crushing force in pounds	Crushing force in pounds per square inch	Began to spawl	Breaking weight for transverse strain	Transverse strength L W 2^{a} S = 4 b d
Athens marble, (Illinois	Transverse	3.75 by 7.9 by 20	1	2.5154	65,700	16,420	65,700	16,900	361.5
Stone Company),		3.9 by 7.05 by 20	2	2.5132	49,000	16,255	49,000	18,580	377.4
Magnesian limestone		4 by 8 by 20	3						
(Niagaran dolomite)	Crushing	2 by 2 by 4		....	64,800	16,700	64,000	16,600	324
				2.5143	60,500	15,125	59,567	17,360	354.3
Athens marble, (Walker),	Transverse	4 by 7.5 by 20	1	2.6629	34,500	8,625	28,000	12,100	172
Magnesian limestone		4 by 8 by 20	2	2.5271	43,700	10,950	39,000	16,800	328
(Niagaran dolomite)		3.8 by 8 by 20	3	2.5246	38,000	9,500	38,000	14,300	294
	Crushing	2 by 2 by 4							
				2.4051	38,733	9,692	35,000	14,400	264.5
Joliet (State Prison)	Transverse	4 by 8 by 20	1	2.6123	40,000	10,000	20,000	13,800	269
Magnesian limestone		4 by 8 by 20	2	2.6086	31,270	7,817	18,000	15,000	293
(Niagaran dolomite)		4 by 8 by 20	3	....	33,000	8,150	19,000	18,800	267
	Crushing	2 by 2 by 4							
				2.6105	34,757	8,656	19,000	15,867	276.5

TABLE 18.—*Table showing certain physical properties of Illinois building stone* [25]—Concluded

Kinds of stone	Dimensions in inches		No. of Samples	Specific gravity	Crushing force in pounds	Crushing force in pounds per square inch	Began to spawl	Breaking weight for transverse strain	Transverse strength $L\ W\ 2^a$ $S = 4\ b\ d$
Magnesian limestone	Transverse	4 by 8 by 20	1	2.6526	64,000	16,000	64,000	15,309	298.7
		4 by 8 by 20	2	2.6354	47,000	11,750	44,000	16,400	220.3
		4 by 8 by 20	3	....	65,500	16,375	65,000	....	248
	Crushing	2 by 2 by 4							
				2.6440	58,883	14,708	57,833	15,850	283
Nauvoo, pure limestone	Transverse	4 by 8 by 20	1	2.6378	31,400	7,850	....	14,600	285
		4 by 8 by 20	2	2.7028	36,200	9,150	....	14,000	273
		4 by 8 by 20	3	....	35,000	8,950	....	14,600	285
	Crushing	2 by 2 by 4							
				2.6703	34,200	8,583	....	14,300	281
LeClaire, (Old Quarry)	Transverse	4 by 8 by 20	1	2.3354	13,000	3,250	11,000	6,590	127.7
Magnesian limestone,		4 by 8 by 20	2	2.3379	13,800	4,700	18,800	6,800	130.5
very impure	Crushing	2 by 2 by 4		....	20,000	5,000	20,000	....	....
Madison County(?)				2.3366	15,600	4,317	16,600	6,695	129.6
LeClaire, (New Quarry)	Transverse	4 by 8 by 20	1	2.3712	24,900	6,225	24,900	7,000	136.6
Magnesian limestone		4 by 8 by 20	2	2.3033	29,800	7,450	25,000	9,100	177
Madison County(?)	Crushing	2 by 2 by 4		....	21,500	5,375	15,000	....	....
				2.3372	25,400	6,350	21,633	8,050	156.8

Andalusia, Magnesian limestone (very impure) Rock Island County	Transverse	3.8 by 7.95 by 20	1	2.3790	24,200	6,050	....	5,900	112
		3.7 by 8 by 20	2	2.4067	28,100	7,025	....	5,000	105
		4 by 8 by 20	3	2.3812	20,000	5,000	....	3,600	103
	Crushing	2 by 2 by 4							
				2.3389	24,100	6,025	....	4,833	107
Sterling, Illinois Magnesian limestone (Pennington)	Crushing	2 by 2 by 4 from top	....	....	27,540	6,885	5,250	....	....
	Crushing	2 by 2 by 4 from bottom	....	....	40,000	10,000	3,250	....	....
Hopkins, Illinois (Pennington)	Crushing	2 by 2 by 4	....	....	34,000	8,500	6,000	....	....
Wills Quarry, Hancock, Ill.	Crushing	2 by 2 by 4 from top	....	2.468	32,100	8,025	25,000	....	....
Wills Quarry, Hancock, Ill. (Magnesian limestone)	Crushing	2 by 2 by 4 from bottom	....	2.387	16,000	4,150	9,000	....	....

[a]The product of the length and width divided by 4 times the breadth and depth gives the transverse strength.

[25]Shaw, James, Geology of Whiteside County: Geol. Survey of Illinois, Vol. V, p. 157, 1873.

TABLE 19.—*Table showing the absorption of Illinois building stone*[26]

Kinds of stone	No. of specimens	Weight before steeping	Weight after steeping	Increase in weight	Per cent increase
		Grains	*Grains*	*Grains*	
Athens (Illinois Stone Company)..	1	5554	5755.5	201.5	3.6
Athens (Illinois Stone Company)..	2	5421	5593.5	172.5	3.1
Athens (Walker)	1	5020	5184	164	3.26
Athens (Walker)	2	5140	5309	169	3.26
Athens (Walker)	3	5230	5400	171	3.26
Joliet (State Prison)............	1	5293.5	5495.3	101.8	1.8
Joliet (State Prison)............	2	5306.3	5432.5	126.2	2.3
Joliet (Sanger)	1	6211.8	6382	170.2	2.73
Joliet (Sanger)	2	6640.5	5800	159.5	2.8
Nauvoo	1	5498	5513.5	15.5	.33
Nauvoo	2	5578.7	5599.5	20.8	.39
LeClaire, new quarry............	1	4999.7	5361.2	361.5	7.23
LeClaire, old quarry.............	2	4333	4674	341	7.8
Andalusia	1	4611	4874	263	5.7
Andalusia	2	4902	5181	279	5.68
Wills quarry, from top...........	1	4798	4924	126	2.5
Wills quarry, from bottom........	2	4425	4701	276	6

REFERENCES ON BUILDING STONE

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Merrill, G. P., Stones for building and decoration.

Richardson, C. H., Building stones and clays, Syracuse, New York, 1917.

Ries, H., Building stones and clay products, New York, 1912.

Stone staining, its causes and prevention: Stone, vol. XLII, no. 12, p. 629, Dec. 1921.

LIMESTONE IN THE MANUFACTURE OF ALKALIES[27]

In the manufacture of alkalies, particularly sodium hydroxide and sodium carbonate, limestone as such or as lime is used as a chemical reagent. As the carbonate, it is used in the Leblanc process for the manufacture of sodium carbonate, and dissociated as lime and carbon dioxide in the common Solvay or ammonia-soda process for making the same alkali. For either of the above processes, it is necessary that the stone be pure and as free as possible from iron oxide, alumina and silica.

ILLINOIS LIMESTONE FOR ALKALI WORKS

Parts of the purer Illinois limestones such as the St. Louis, Burlington, and Kimmswick would be suitable for use in the preparation of alkalies, as indicated by the table of chemical anaylses (Table 17).

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[26]Shaw, James, Geology of Whiteside County: Geol. Survey of Illinois, Vol. V, p. 158, 1873.

[27]Mount, W. D., Lime in the manufacture of alkalies: Rock Products, Vol. XXIV, No. 19, p. 31, September 10, 1921.

Limestone in the Refining of Sugar

Limestone is used as lime in the refining of white sugar from the juice of cane or beets by the carbonation process. The stone is burned at the refinery in specially constructed kilns and both the lime and carbon dioxide produced are utilized. In other processes for the manufacture of raw, yellow or white sugar, the carbon dioxide is not used and the lime is generally not burned at the refinery. In both cases the lime is used as a purifying agent.

REQUIREMENTS FOR THE LIMESTONE

The limestone burned for lime "should contain at least 95 per cent of the pure substance, calcium carbonate, and not more than 1 per cent of any one of the following impurities:—magnesia, iron oxide, alumina, silica, sulphur trioxide, and matters insoluble in hydrochloric acid"[28]. The lime burned from the limestone "should not contain more than 2 per cent of any one of the above mentioned impurities and of carbon dioxide and moisture and not more than 0.5 per cent of sulphur trioxide."[28]

ILLINOIS LIMESTONES SUITABLE FOR SUGAR REFINING

Table 17 containing chemical analyses shows that parts of the St. Louis, Burlington and Kimmswick limestones are of a sufficiently high degree of purity to furnish a stone suitable for use in the sugar refining industry.

Limestone and Dolomite in the Manufacture of Refractories [29]

Limestone in the form of lime is used as a bond for the silica in silica brick, and under the influence of heat reacts with the silica to form calcium silicate. A high grade lime is desirable for this purpose.

Calcined dolomite is used for the manufacture of brick used in place of magnesia brick as a basic lining for furnaces. The bricks are made by grinding calcined dolomite to a fine powder, mixing the powder with water and molding them to the desired shape, or, by dead burning dolomite and binding the resulting product with tar or pitch.

REQUIREMENTS FOR DOLOMITE IN MAKING BRICK

Dolomite used for making brick should contain about 33 per cent calcium oxide, 18 to 20 per cent magnesium oxide, 42 to 46 per cent carbon dioxide, and not more than 7 per cent silica, or 5 per cent iron oxide and alumina. The burned dolomite should contain about 56 or 57 per cent of calcium oxide, about 35 per cent magnesium oxide, less than 4 per cent of iron oxide and alumina, and 2 per cent or less of silica.[30]

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[28]Heroit, T. H. P., The manufacture of sugar from cane and beet, London, p. 161, 1920.

[29]Parr, S. W., and Ernest, T. R., Sand-lime brick: Ill. State Geol. Survey Bull. 18, 1912.

[30]Searle, A. B., Refractory materials, pp. 121, 250, London, 1917.

ILLINOIS LIMESTONES FOR REFRACTORIES [31]

An examination of the table of chemical analyses (Table 17) shows that the dolomites of northern Illinois, particularly parts of the Niagaran, Galena, and Platteville are well suited for use in making dolomite brick.

Limestone in the Manufacture of Paper

There are at present four principal methods of preparing paper pulp from woods of various sorts, which involve the use of chemicals in the process. These are the sulphite, soda, sulphate and Kraft processes. The end in view of all these processes is to remove all materials from the raw wood except the cellulose.

The sulphite process is used principally in making pulp from resinous wood such as spruce and hemlock. The wood as chips is digested under conditions of high temperature and pressure with bisulphite of lime solution, commonly known as the acid liquor. The sulphite liquor may be prepared by either of two methods, the milk of lime or the tower system. In the former, the stone, commonly dolomite is first burned to lime. It is then suspended in water (milk of lime) and allowed to react with sulphur dioxide gas, which in the presence of water forms sulphurous acid. The product resulting from this reaction is calcium and magnesium sulphite. The chemical equations for these reactions are as follows:

$$SO_2 + H_2O = H_2SO_3$$

$$Ca(OH)_2 + Mg(OH)_2 + 2\ H_2SO_3 = Ca\ SO_3 + Mg\ SO_3 + 4\ H_2O$$

In this system a highly dolomitic lime is preferred.

In the tower system, a cylindrical or conical tower is filled with lumps of limestone or dolomite, which are kept moist by a spray of water from above. Sulphur dioxide gas enters the tower at its base and passes upward. With the water it forms sulphurous acid which reacts with the stone in the tower to form calcium sulphite if a limestone is used, or calcium and magnesium sulphites if a dolomite is used. The chemical equations for the reactions which take place are as follows:

$$SO_2 + H_2O = H_2SO_3$$

$$CaCO_3 + H_2SO_3 = CaSO_3 + CO_2 + H_2O$$

After either of the two above mentioned systems has been in operation for a time, an excess of sulphurous acid is formed, and the final product of the reactions is a solution of calcium bisulphite if limestone or lime made from it are used, or calcium and magnesium bisulphite if a dolomite or dolomitic lime has been used.

The soda process of making paper pulp is commonly used on poplar, basswood, cottonwood, and similar woods. The wood in the form of small

[31] Havard, Refractories and furnaces, p. 96.

chips is digested with sodium hydroxide. This material is prepared at the mill by treating sodium carbonate with lime. The reaction which takes place is as follows:

$$Na_2CO_3 + CaO + H_2O = 2NaOH + CaCO_3$$

The calcium carbonate produced in this process is generally a waste product, although in places it is sold for agricultural purposes. At some plants it is reburned and the resulting lime used again in the making of sodium hydroxide.

The sulphate and Kraft processes are modifications of the soda process. Limestone or dolomite is used in making the digesting liquor as in the soda process.

REQUIREMENTS FOR STONE IN PAPER MANUFACTURING

Stone burned for lime to be used in the milk of lime system should be as high in magnesia as possible and essentially free from iron and silica. The lime burned from it should slake easily.

Either limestone or dolomite is used in the tower system. The dolomite produces a tougher paper than the limestone, but limestone is generally preferred to dolomite if it is obtainable. In either case, the stone should be as free as possible from silica, iron and dirt, and in the case of a limestone, be low in magnesia. A porous stone is generally preferable.

ILLINOIS LIMESTONES IN PAPER MANUFACTURE[32, 33]

The dolomites of northern Illinois that are low in silica when burned would make suitable highly magnesium lime for use in the milk of lime system. Some of the Pennsylvanian limestones, and parts of the Okaw, Ste. Genevieve, St. Louis, Salem, Burlington, Hamilton and Kimmswick limestones would furnish a pure stone suitable for use in the tower process.

Limestone in the Manufacture of Glass[34-37]

Common glass is a silicate of calcium and sodium made by melting together sand (SiO_2), sodium carbonate, and limestone or lime. Formerly lime was used almost exclusively in glass making, but recently it has been supplanted very largely by crushed limestone. The amount of stone used constitutes about a fifth of the glass batch.

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[32] Sutermeister, E., Chemistry of pulp and paper making, New York, 1920.

[33] Witham, G. S., Sr., Modern pulp and paper making, New York, 1920.

[34] Weeks, J. D., Glass materials: U. S. Geol. Survey Mineral Resources 1883-1884, pp. 958-977, 1885; 1885, p. 548, 1886.

[35] Burchard, E. F., Glass sand, other sand and gravel: U. S. Geol. Survey Mineral Resources 1911, p. 595, 1912.

[36] Pettke, C. R., Glass manufacture and the glass sand industry of Pennsylvania: Topog. and Geol. Survey Pennsylvania, Report No. XII.

[37] Mathews, E. B., and Grasty, J. S., The limestones of Maryland: Maryland Geol. Survey Vol. VIII, pt. III, p. 234.

REQUIREMENTS OF LIMESTONE FOR GLASS MAKING

It is desirable primarily, that a limestone used in glass making be as pure as possible and that it occurs in beds of fairly uniform composition. According to Shively[38] the total calcium and magnesium carbonate content should not be less than 93 per cent. The effects of common impurities in limestone on glass are as follows:

Alumina.—If present in glass in comparatively large quantities, alumina gives to it certain desirable and certain undesirable properties with the latter dominant. In ordinary glasses, however, small amounts of this compound (less than about 3 or 5 per cent) are not commonly considered harmful. The amount of alumina permissible in a limestone to be used in glass making varies according to the amount of that compound in the glass sand, and the character of the glass being made.

Silica.—If disseminated in fine particles throughout a limestone, silica is commonly not harmful. Care should be exercised however, that there are no small fragments of chert or other forms of silica present in the limestone except in a finely divided condition, or opaque spots will be formed in the finished glass.

Iron.—This element occurs in limestones most commonly as the hydroxide or sulphide. If present in the ferric condition, iron gives the glass a yellow color, and if present in the ferrous condition, a bluish green or green color. It is the substance most to be avoided in limestones for use in glass making. Shively[39] specifies that in general the iron content of limestones should not be over 0.1 per cent ferric oxide (Fe_2O_3). Rosenhain is quoted[40] as stating that for the better grades of glass the iron should not exceed 0.3 per cent.

Magnesia.—Magnesia is generally avoided in limestones to be used for glass making. It is commonly specified that such limestones should contain less than 5 per cent of magnesia.

Other impurities.—Silicates of calcium, magnesium and aluminum, and amorphous calcium phosphate from fossil remains, are sometimes found in limestones. These tend to form small white masses in the glass and therefore are undesirable in limestones. Organic material is reported to give glass a dark color and should also be avoided.

ILLINOIS LIMESTONE IN GLASS MANUFACTURE

It is obvious that the magnesium limestones and the dolomites of northern Illinois may be eliminated as possible sources of limestone for use in

[38]Shively, R. R., Lime in glass making: Rock Products, vol. XXVII, No. 18, p. 32, Sept. 8, 1923.

[39]Idem.

[40]Pettke, C. R., Glass manufacture and the glass sand industry of Pennsylvania: Topog. and Geol. Survey of Pennsylvania, Report No. XII, p. 74.

glass manufacture because of their high magnesia content. In the southern and southwestern parts of the State, however, some of the Pennsylvanian limestones and parts of the Menard, Okaw, Ste. Genevieve, St. Louis, and Kimmswick limestones are suitable for this purpose because of their purity. The table of chemical analyses (Table 17) of Illinois limestones gives analyses of these limestones.

Whiting[41]

Whiting is very finely pulverized chalk, marble, or limestone. Good whiting has a specific gravity of 2.8. It is used in paints because of its neutralizing effect on the free acid in the linseed oil and its even spreading qualities. Whiting is also used in the ceramic industry, "to furnish the calcium oxide component of glazes, enamels and fluxed ceramic bodies".[42] Other uses of whiting are for shoe whiting, silver polish, putty, in the manufacture of rubber and linoleum, and, when mixed with a little bonding clay, for blackboard crayon. If it is extremely pure, it is known as "gilders or Paris white".

REQUIREMENTS FOR LIMESTONE IN THE MANUFACTURE OF WHITING

A limestone which is to be ground for whiting should be very pure, and particularly should be free from silica or grit. It is also desirable that it be relatively soft so as to be easily ground or pulverized. For ceramic whiting it is recommended that the rock from which the whiting is made be practically free from pyrite, iron bearing silicates, metallic iron and gypsum; also that the total carbonates in the whiting should not vary more than 1 per cent from 97 per cent and the silica not more than 0.5 per cent from 2 per cent.[42]

ILLINOIS LIMESTONE FOR WHITING

Whiting is manufactured at Elsah in Jersey County at Quincy in Adams County, and at Alton in Madison County. At Elsah, the Burlington limestone is used and at Alton the St. Louis or Ste. Genevieve. The product from both places is reported to be of high quality. Elsewhere in the State, particularly in the southwestern and southern portions, parts of the Okaw, Ste. Genevieve, St. Louis, Burlington, and Kimmswick limestones would furnish a high quality stone for the manufacture of whiting.

Magnesian Limestone as a Source of Magnesia[43]

Dolomites which contain from 15 to 22 per cent of magnesia are used in some places as a source of magnesia. The process of separating the magnesia from the other constituents of the stone is a chemical one and in-

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[41]Cement, mill and quarry, Vol. XX, No. 8, p. 38, April 20, 1922.

[42]Recommended specifications for ceramic whiting: U. S. Bur. Standards Circular No. 152, p. 2, Dec. 8, 1923.

[43]Eckel, E. C., Cements, limes and plasters, p. 156, 1905.

volves the precipitation of the magnesia as such or as the hydroxide which is easily convertible into the oxide.

This product finds its most extensive use in the manufacture of magnesia or magnesite brick.

ILLINOIS DOLOMITES AS A SOURCE OF MAGNESIA

The Niagaran and Galena dolomites show a high magnesia content and could be used as a source thereof.

Limestone in Aluminum Refining

In extracting aluminum from the ore bauxite, sodium hydroxide is used as a solvent for the metal. The sodium hydroxide is made from lime and sodium carbonate. As aluminum in the metallic state must be 99.3 per cent pure, it is necessary that the lime used in the process also be very pure.

REQUIREMENTS FOR THE LIMESTONE IN ALUMINUM REFINING

The limestone to be burned for lime for use in aluminum refining should contain at least 97 per cent calcium carbonate and not over 1 per cent silica and should retain its form during burning.

ILLINOIS LIMESTONES FOR ALUMINUM REFINING

The Kimmswick and Salem limestones are used at the present time as a source of lime in the refining of bauxite. In addition, the non-cherty part of the Burlington limestone, and parts of the St. Louis and Hamilton limestones would be suitable for this purpose as indicated by the table of chemical analyses (Table 17).

Limestone in Filter Beds

Limestone or dolomite is used in the construction of sprinkling or trickling filters for sewage purification. The stone constitutes the bed of the filter and serves as a place of lodgment and of development for the bacteria which purify the sewage. The stone is commonly used in 1½- to 2-inch fragments and in some cases in smaller sizes.

Experience has demonstrated that some limestones and dolomites give longer service in a filter bed than others. Detailed data on this phenomenon are not available so that its causes can only be surmised. It does seem probable, however, that solution by the sewage water is the most important agent in the destruction of the filter stone. Under a given set of conditions the rate of solution of a stone in a filter bed depends on its surface exposed to the solvent and on its mineralogical composition. The more surface exposed to the solvent the more rapid is the solution. Therefore a dense stone would be preferable to a porous one.

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[44]Aluminum Ore Company, East St. Louis, Ill. Personal communication.

Limestone is composed essentially of calcium carbonate, and dolomite, of calcium and magnesium carbonates in varying proportions up to about 55 and 45 per cent respectively. Magnesium carbonate is more slowly soluble than is calcium carbonate. The advantage of the slower solubility of the dolomite is offset, however, by the fact that many dolomites develop a very porous exterior when they dissolve, thereby affording more surface on which the solvent may act than would a similarly sized fragment of limestone.

Filter stone should be free from clay partings and pyrite in order that a possible disruption of the stone into smaller fragments should not be facilitated when the stone is exposed to the processes of mechanical weathering.

Because so little is known about desirable properties in filter stone, recommendations of specific Illinois limestones or dolomites for such a purpose are not made. It may be suggested however that some of the highly siliceous limestones of the State, which contain the silica interspersed with the calcite crystals, rather than as chert nodules or segregations of silica, might give very good service in filter beds.

Use of Limestone and Dolomite for Rock Dusting Mines[45, 46]

It has been found that by spreading incombustible rock dust in coal mines in such a manner and in such quantities that it constitutes over 50 per cent of the dust in the mine, explosions from the combustion of coal-dust are minimized, and in fact practically obviated. As some of the stone dust becomes mixed with the air in the mine and is breathed by the miners, it is essential that the dust should not be injurious to the lungs. It is of prime importance, therefore, that none of the rock powders used in stone dusting contain sharp, angular siliceous particles, for these are harmful to the lungs. Limestone, dolomite, shale and gypsum have been used satisfactorily.

Limestone and dolomite powders are very suitable for dusting mines because in general they contain a very small per cent of siliceous materials; they are not carbonaceous; and because they are white or light colored and therefore increase the effectiveness of the illumination when adhering to the roof and walls of a mine. The light color of the powder in contrast with the black of the coal-dust makes the quantity of powder mixed with the coal-dust easily estimated.

There is some difference of opinion as to the most effective size of rock dust particles. The British government requires that 50 per cent of the dust pass a screen of 200 linear mesh to the inch and assumes that all of it will pass a 20-mesh screen. The requirements stated by the

[45]Stone dusting or rock dusting to prevent coal-dust explosions as practiced in Great Britain and France, U. S. Bur. Mines Bull. 225.

[46]Tentative specifications for rock dusting to prevent coal dust explosions in mines: U. S. Bur. of Mines Serial No. 2606, May, 1924.

United States Bureau of Mines as the result of their investigations are in general agreement with those of the British government.

ILLINOIS LIMESTONE AND DOLOMITE FOR STONE DUSTING OF MINES

Any of the quarried limestones and dolomites of the State, except those which are sandy or cherty and therefore might contain angular particles of silica, can be used for rock dusting. Some of the Pennsylvanian limestones may furnish supplies for some mines. There are also shaly limestones, in western Illinois particularly, which might lend themselves to the production of rock dust. The argillaceous material in them would be no hindrance to their use and the comparative ease of pulverizing is a considerable advantage.

Limestone or Dolomite in Stucco and Terrazzo Work

Crushed limestone or dolomite is used for stucco and terrazzo work. The most important requirements are that the stone chips be of uniform size and of pleasing color. The chips are used commonly in small sizes, and certain oxidized colors, particularly those resulting from the weathering of iron minerals within the stones, are favored. In addition, it is desirable that the stone retain its color, and, if used for stucco, have good frost-resisting qualities.

Limestone for the Manufacture of Carbon Dioxide

Carbon dioxide is commonly made by treating limestone or marble with dilute hydrochloric acid. The gas is used extensively for charging mineral waters and carbonated beverages. Limestone for this purpose should contain a minimum of impurities in order that its carbonate content may be as large as possible.

Lithographic Limestone

Small quantities of limestone are used in lithography. Stone for this purpose should be very fine and evenly grained, and be free from gritty impurities such as sand grains. It is relatively rare and because the demand is small and for a long time has been supplied by imports from Germany, no great endeavor has been made to develop existing deposits in this country. Some of the Illinois limestones, particularly parts of the St. Louis, Ste. Genevieve, and Hamilton, are semi-lithographic in part, but none exhibit consistently the true lithographic character.

Chemical Uses of Limestone

Limestone has numerous applications in the manufacture of various chemicals, but it is commonly employed as lime. The primary requirements of a limestone for use in the chemical industry either as ground limestone or lime are that it be as free from impurities as possible, that is, be nearly 100 per cent calcium carbonate.

Other Uses of Limestone and Dolomite[47-49]

In addition to the uses mentioned above, limestone and dolomite are employed for the following purposes:

- Asphalt filler (ground to pass 200-mesh)
- Roofing gravel
- Mineral wool
- Poultry grit
- Manufacture of powder
- Rubber filler (limestone ground to pass 300-mesh)
- Clay filler
- Fertilizer filler
- Manufacture of artificial stone
- Plaster finish (finely crushed)

[47]Cement, Mill and Quarry, Vol. 17, No. 6, p. 19, Sept. 20, 1920.

[48]Chemical Age, p. 377-380, Oct., 1920.

[49]Loughlin, G. F. and Coons, A. T., Stone: U. S. Geol. Survey Mineral Resources 1920, p. 250, 1923.

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